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23 July 1979

USSR Report

BIOMEDICAL AND BEHAVIORAL SCIENCES

(FOUO 2/79)



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USSR REPORT
BIOMEDICAL AND BEHAVIORAL SCIENCES

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AGROTECHNOLOGY

CONTRIBUTION OF BIOLOGY TO ADVANCES IN AGRICULTURE DESCRIBED

Moscow IZVESTIYA AKADEMII NAUK SSSR-SERIYA BIOLOGICHESKAYA in Russian No 3, 1979 pp 477-479

Report on general meeting of the USSR Academy of Sciences by Shcherbinovskaya, T. N.: "Session of the General Meeting of the Department of General Biology of the USSR Academy of Sciences 'General Biology for Agriculture'"

Text The session of the general meeting of the Department of General Biology of the USSR Academy of Sciences "General Biology for Agriculture" was held in Moscow on 4-5 December 1978. M. S. Gilyarov, academic secretary of the department, opened the session. In his introductory speech he noted that the Communist Party pays much attention to the problems of agriculture, which is indicated by the decisions of the 25th CPSU Congress and of the July and November (1978) plenums of the CPSU Central Committee and by Comrade L. I. Brezhnev's speeches. Agricultural production as the production of biological objects is based on the data of biology, which places great responsibility for the elaboration of fundamental problems of agricultural science and practice on biologists. Such are the problems of productivity and anthropogenic changes of biocenoses and agrocenoses, migration and behavior of harmful and useful species, integrated control of pests and diseases of agricultural crops, genetics and selection, individual development of organisms, maintenance of soil fertility, efficient methods of fertilizer application and so forth. Our country has the right to expect from biologists their contribution to the increase in the productivity of agriculture.

The report by academician N. P. Dubinin "Genetics at the Service of Selection" reflected the history of the problem of genetics and selection in our country based on the activity of outstanding scientists--N. I. Vavilov, I. V. Michurin, A. S. Serebrovskiy, P. P. Luk'yanenko, V. S. Pustovoyt and others. The utilization of fundamental achievements of modern genetics plays an important role in the advances of selection. Such are the achievements of experimental polyploidy in the development of triploid heterosis hybrids of sugar beets and potatoes, genetically regulated heterosis as the basis for advances in the cultivation of sunflowers, modal selection in work

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with cotton, radiation mutagenesis for the development of winter wheat varieties, polyploidy and hybridization in yeast selection, attenuated mutants and protection of vegetable crops under greenhouse conditions, modern approaches to the selection of breeds and lines meeting the requirements of industrial livestock breeding and inbreeding and methods of microsurgery on zygotes. The speaker threw light on the work connected with agricultural practice carried out in the Institute of General Genetics of the USSR Academy of Sciences, including on the elaboration of methods of developing animal breeds and plant varieties maximally adapted to methods of agricultural management under conditions of agroindustrial and livestock breeding complexes.

Academician V. N. Remeslo made the report "Wheat Selection at the Service of Production." He noted that in the last few years workers in agricultural science and production made important advances, which was aided by the measures of the Communist Party for the implementation of a system of efficient measures for an increase in grain production and in the sale of bread to the state. The speaker described the work done under his guidance at the Mironovskaya Selection Station. As a result of long-term investigations of the patterns in the inheritance of economically valuable characters, a new winter wheat variety of the intensive type, Mironovskaya-808, was developed. It is a masterpiece of world, not only Soviet, selection. It is plastic and is widespread in various zones of our country and in many foreign countries. Other varieties--Yubileynaya, Il'ichevka, Mironovskaya yubileynaya and so forth--were also developed. Four new winter wheat varieties--highly productive, winter resistant and with a good quality of grain--are being tested. Work is being done on the development of spring wheat varieties.

B. A. Neunyllov, corresponding member of the USSR Academy of Sciences, made a report on the biological principles of rice sowing in the Far East, where there are favorable conditions for the cultivation of this crop and where it occupies large areas. Among urgent problems the speaker noted the breeding of especially early ripening varieties with an increased resistance to low temperatures, search for methods of accelerating the processes of organogenesis under conditions of lower temperatures by affecting the physiologobiochemical functions of plants and the regulation of their nutrition, as well as improvement in the microclimate of the rice field and protection from weeds, pests, diseases and so forth.

The report by academician Ye. M. Lavrenko, T. I. Isachenko and S. A. Gribova (Botanical Institute of the USSR Academy of Sciences) was devoted to the present maps of the vegetative cover and their importance for agriculture. Depending on their scale geobotanical maps can be used for statewide planning and for the implementation of operational-economic measures. These maps are needed for the solution of various practical problems, that is, in the evaluation of ecological conditions and the selection and classification of land occupied by natural vegetation, development of new territories, reclamation, planning of the use and reconstruction of agricultural production, protection of the plant world and so forth.

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On 5 December K. M. Ryshikov, corresponding member of the USSR Academy of Sciences, made a report on the scientific principles of the prevention of helminthiases in farm animals. He showed the close connection between helminthology and agriculture. The investigations of Soviet helminthologists are directed toward the solution of general biological, veterinary and medical problems. Biological problems include the study of the specific composition of helminths, their geographical distribution, morphologotaxonomic characteristics, ecology, physiology and biochemistry. The results of this work form the basis for all the practical measures for the control of helminths and for the protection of farm animals from them. Extensive research aimed at controlling helminthiases in cattle and poultry is conducted in the Laboratory of Helminthology of the USSR Academy of Sciences. The speaker noted the outstanding role of academician K. I. Skryabin in the development of Soviet helminthology and in the elaboration of measures for the control of helminthiases in our country.

The report by M. V. Gorlenko, corresponding member of the USSR Academy of Sciences, was devoted to the state of and prospects for the biological method of plant protection from diseases. The problem of the biological method of plant protection from diseases lies in the use of antagonistic microbes or products of their vital activity for suppressing infectious diseases in plants. A number of preparations for the control of bacteria in pulse crops, powdery mildews and tomato bacterioses were developed. It is necessary to intensify the work on the genetics of producers, search for new antagonists, study of the cross protection of plants and giving them immunity to diseases through primary inoculation with nonpathogenic microbes or weakly pathogenic strains of pathogenic microbes. This method is already successfully used in hot-houses for the control of the tobacco mosaic virus on tomatoes.

Candidate of Biological Sciences Ye. S. Sugonyayev (Zoological Institute of the USSR Academy of Sciences) reported on the experience in the development of an integrated system of protection of cotton from pests on a biocenological basis. An intensified application of toxic chemicals against harmful organisms often leads to negative consequences. As a result of a careful study of this problem the task of developing systems for the control of populations of harmful and useful species (integrated systems) arose. The speaker illustrated the use of such a method, using as an example the cotton fields in Tadzhikistan and Turkmenia, which produced very positive results--increase in the yield of cotton and reduction in the contamination of fields with pesticides.

Doctor of Biological Sciences M. V. Krylov (Zoological Institute of the USSR Academy of Sciences) made the report "Theoretical Basis for the Control of Coccidiosis in Poultry and the Introduction of Scientific Developments Into Industrial Poultry Breeding." He noted a number of serious investigations in the field of metabolic interactions of parasites and the host organism and biochemical changes in the host organism caused by the parasitism of coccidia, that is, shifts in the metabolism of protein, nucleic acids, trace elements and so forth. A number of theoretical substantiations for the use of pathogenetic therapy and purposeful synthesis of inhibitors of metabolic processes in parasites were developed. Many of these data have already been realized in practice and give an important economic effect.

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The report by academician M. S. Gilyarov "Biological Methods of Increasing Soil Fertility" noted the outstanding role of Soviet scientists in the study of the role of organisms in soil forming processes and in the maintenance of soil fertility. The speaker dwelled on some methods connected with the possibilities of utilization of biological agents for an increase in soil fertility, in particular the activity of earthworms. The report described in detail the taxonomic and ecological aspects of this group of invertebrates. Numerous experiments showed the effectiveness of artificial introduction of certain species and ecological groups of worms into localities where these species are not found for historical reasons, but where they can exist according to ecological conditions. The application to field soil, in particular to nonchernom soil, of especially composted organic fertilizers of different origin at the stages of decomposition, when useful invertebrate soil formers accelerating the mineralization and humification of plant residues and aiding in the aeration, drainage and structure formation of soil are reproduced in it, is another trend in the research on biological soil reclamation. For large livestock breeding (primarily hog breeding) farms the method of manure processing with the use of fly larvae developed in Novosibirsk is promising both for obtaining composts and for providing hog farms with valuable protein fodder.

The report by Candidate of Agricultural Sciences S. D. Erpert (Laboratory of Forest Science of the USSR Academy of Sciences) "Effect of Forest Plantings on the Productivity of Agricultural Crops" threw light on the set of measures for increasing the yield of agricultural crops in the semideserts of the Northern Caspian Region (according to the data of the group of workers at the Dzhanlybek Station). The arid climate and salinity of soil complicate its development for farming. The station developed the scientific basis for the agricultural reclamation of the semidesert complex of the intervalley plain under conditions of nonirrigated land. As a result of long-term research, a system for the development of soil of the semidesert complex for farming was developed. Specific measures for reclamation, plowing of solonetz, snow retention, use of windbreak strips and so forth were proposed.

Doctor of Biological Sciences R. V. Kamelin (Botanical Institute of the USSR Academy of Sciences) made the report "Botany at the Service of Agriculture." He pointed out that all the sections of botanical science have direct applications in the practice of agriculture. He noted the most important of these problems, that is, the anthropogenic destruction of the vegetative cover, new crops (fodder plants, artificial hayfields and pastures, new industrial crops and so forth), reclamation of the natural fodder base, overall natural regionalization (efficient placement of various types of land) and protection of the plant world.

The general meeting adopted a decree determining the basic trends in scientific research in the field of study of plant and animal biology for the purpose of increasing plant and animal productivity and developing methods of raising new plant varieties and highly productive animal breeds; expansion

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of work on ecology, biological methods of integrated protection of plants and animals from pests and parasites, biological methods of increasing soil fertility, development of forecasts of changes in the natural environment under the effect of anthropogenic factors and so forth. The need for the further development of overall research conducted jointly with the institutions of VASKhNIL /All-Union Academy of Agricultural Sciences imeni V. I. Lenin/ and the USSR Ministry of Agriculture was noted.

The bureau of the Department of General Biology was instructed to systematically examine at its meetings the course of fulfillment of joint work on the agricultural problems of the institutions of this department and VASKhNIL.

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AGROTECHNOLOGY

CONTRIBUTION OF BIOCHEMISTRY, BIOPHYSICS TO AGRICULTURE DISCUSSED

Moscow IZVESTIYA AKADEMII NAUK SSSR-SERIYA BIOLOGICHESKAYA in Russian No 3, 1979 pp 475-476

Report on general meeting of the USSR Academy of Sciences by Samsonov, S. K.: "Session of the General Meeting of the Department of Biochemistry, Biophysics and Chemistry of Physiologically Active Compounds Devoted to Agriculture"

Text Opening the meeting held on 4-5 December 1978, academician A. A. Bayev, academic secretary of the department, noted the weighty contribution of the department's institutes to the elaboration of urgent problems connected with the development of agriculture set by the decisions of the July (1978) Plenum of the CPSU Central Committee. In the near future investigations connected with an increase in the productivity of agricultural production should be expanded considerably.

V. A. Kovda, corresponding member of the USSR Academy of Sciences, made the report "Prospects for the Reclamation and Productivity of Soil in Plain Regions of the USSR." The rapid growth of our country's population sets the task of obtaining an average harvest of grain crops of no less than 30 quintals per hectare, which will ensure the necessary level of consumption and self-provision with fodder resources and of meat and milk production. This will require considerable efforts for the preservation of available plots of land and a considerable increase in their productivity. The further increase in land productivity will undoubtedly require large-scale operations for improving its physical, biochemical and agroecological properties.

The present ecological conditions of dry land are characterized by an increase in moisture deficit. Therefore, the development of a long-term forecast of ecological conditions and the real need for reclamation and for ensuring an optimal situation for the growth of cultivated plants connected with this is one of the tasks of fundamental science. The problems of transferring the water resources of the north to arid southern regions and the need for a significant rationalization of the use of available water supply sources used for irrigation needs arose on this basis. The control of erosion processes inflicting serious damage on our economy is no less important. Implementation of the enumerated measures will make it possible to attain the desired increase in the yield of agricultural crops in the next few years.

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The report by Candidate of Biological Sciences T. A. Kalininskaya (Institute of Microbiology of the USSR Academy of Sciences) was devoted to nonsymbiotic nitrogen fixation and its role in an increase in soil fertility. These processes are of great importance for the development of agriculture. The increase in the application of nitrogen fertilizers by no means eliminates the task of most fully utilizing biological nitrogen fixation for an increase in harvests. For now two representatives of nonsymbiotic nitrogen fixers, that is, Azotobacter and Clostridium, remain the most thoroughly studied. Investigations conducted in the last few years have shown that facultative-anaerobic nitrogen fixing bacilli are also widespread in soil. There are no less nitrogen fixers from the group of facultative-symbiotrophic microorganisms in soil. Their study is now conducted in the laboratory of academician Ye. N. Mishustin. Cyanobacteria developing in water-logged soil are a very interesting group of free-living nitrogen fixers. They are very sensitive to the application of mineral nitrogen, which suppresses their vital activity, and for their use in agriculture as nitrogen fixers it is necessary to develop new strains resistant to such an effect. The above-stated makes it possible to draw a conclusion on the presence of a large stock of free nitrogen fixers in soil. Intensification of their vital activity can increase the content of nitrogen available to plants in soil to a considerable extent.

Almost twice as much agricultural produce has begun to be produced in the world during the last quarter of the century, but the losses from pests and diseases have tripled. This was stated in the report by Doctor of Agricultural Sciences L. V. Metlitskiy "Biochemical Mechanisms of Phytoimmunity and Their Role in the Resistance of Plants" (Institute of Biochemistry imeni A. N. Bakh of the USSR Academy of Sciences). Therefore, along with an improvement in the existing methods of plant protection, a search for more promising, new methods is needed. The scientist discussed the resistance of plants to parasitic fungi manifested in a defense reaction causing a quick death of cells infected with a parasite. On the whole, phytoimmunity is based on a set of defense reactions. The search for ways of increasing the potential capacity of plants for defense reactions, in particular, by means of substances harmless for the environment seems promising.

A. A. Nichiporovich, corresponding member of the USSR Academy of Sciences, presented the report "Potential Photosynthetic Productivity of Plants and the Principles of Its Optimum Use." At the present stage of special importance is the task of increasing the activity of the photosynthetic apparatus at the genetic level. Proceeding from the fact that the maximum possible productivity can be attained with 8-quantum expenditures of photosynthesis, the author notes the conditions necessary for this and the activity of photosynthesizing systems at various levels of their organization. It has been shown that in their best condition, with a good combination of all photosynthetic systems, it is possible to assimilate the incoming energy of photoactive radiation with efficiency of 12 to 14 percent and during the entire period of vegetation, with efficiency of 4 to 5 percent. The principles of closeness of the present levels of productivity to theoretically substantiated levels are evaluated as optimal.

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The report by Doctor of Biological Sciences N. S. Petinov (Institute of Plant Physiology imeni K. A. Timiryazev of the USSR Academy of Sciences) gives a physiologobiochemical substantiation for a high productivity of grain crops and grasses for irrigated conditions. It has been demonstrated that, as soil moisture and mineral nutrition improve in ontogenesis, physiological processes are activated. This contributes to a more intensive accumulation of the dry substance and to an increase in the yield. Optimal conditions under which the greatest productivity of cultivated plants is attained have been obtained experimentally. The principles of controlling the physiological processes of growth and development of grasses for an increase in the resistance to lodging by means of retardants and antiauxins are being developed. In particular, in 1978 chlorocholine chloride was applied on an area of 6 million hectares, which increased the harvest of winter and spring wheat from 2 to 5 quintals per hectare.

In his report Doctor of Biological Sciences A. A. Prokof'yev (Institute of Plant Physiology imeni K. A. Timiryazev of the USSR Academy of Sciences) discussed the problems of an efficient distribution of assimilators throughout plant organs. It is necessary to clearly differentiate the biological and economic productivity of plants, striving for the transport of substances in the plant for the purpose of storing them in organs of economic interest. The author clarified the ways of supply by assimilates of fruits in a number of plants. The order of fruit nutrition was established. Especially interesting results were obtained in work with cotton. Regulation of the flow of assimilates for the purpose of increasing fruit bearing was attained by the use of a number of physiologically active substances. The cotton harvest was 12 to 15 percent higher with a simultaneous earlier ripening of bolls. An earlier clearance of the plot of cotton made it possible to promptly sow winter vegetating fodder crops and to gather a harvest of green mass amounting to 205 quintals per hectare in the spring. A second harvest on the same land is impossible with later cotton crops. As a result, along with an increase in the cotton harvest, the provision of livestock breeding with green fodder without an increase in the area of plots of land is solved.

Presenting the report "Tissue Culture and an Increase in the Productivity of Agricultural Plants," R. G. Butenko, corresponding member of the USSR Academy of Sciences, noted that in 40 years plant tissue culture was transformed into a field of study of cell biology, including genetics of somatic cells, biochemistry and physiology of their growth and differentiations. Mastering the hybridization of somatic cells opened up the possibilities of obtaining changed cell lines and, on their basis, new plants. This process is regulated mainly by the hormonal factor. A practical way was outlined for an artificial formation of new forms of cultivated plants possessing previously unknown valuable properties, in particular resistance to viral infection, which destroys a significant part of the harvest. At the laboratory level methods of sanitation and clone reproduction were developed for 200 plant species. This is also important for a fundamental acceleration of the development of new varieties, that is, 2 instead of 11 or 12 years. Economic

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profitability also increases several times. Hybridization of somatic cells makes it possible to overcome the barrier of incompatibility in the sex process and to develop plant forms lacking in nature.

The report by A. M. Kuzin, corresponding member of the USSR Academy of Sciences, was devoted to radiation methods in agricultural production. Numerous ways of utilizing ionizing radiation in the practice of agriculture were proposed on the basis of fundamental research in the field of radiobiology. The author examines the present state of the problem of substantiating the semiproduction and production check of the proposed methods. It is concluded that economically advantageous, new radiobiological techniques now appear. Their wide introduction into agricultural production requires decisions at a state level on the development of specialized equipment, training of service personnel and general work organization under production conditions.

Grain forms the basis for the productivity of animals, but it is not economical to use it without enrichment with lacking nutrients. This was stated by V. N. Bukin, corresponding member of the USSR Academy of Sciences, in his report "Amino Acids, Vitamins and the Productivity of Animals." It is recommended that the ground grain envisaged for fodder is subjected to extrusion, which makes it more nutritive and close in protein value to soybean oil meal. It is no less important to enrich grain with protein additives and scarce amino acids. The production of the latter must be increased. Nor does the profitability of a regular use of vitamins in the feeding of farm animals evoke any doubt, for which the need of livestock breeding for them should be met fully.

The last report heard at the session was by Candidate of Biological Sciences V. K. Yeroshin (Institute of Physiology and Biochemistry of Microorganisms of the USSR Academy of Sciences) "New Sources of Obtaining Microbiological Protein."

The general meeting of the Department of Biochemistry, Biophysics and Chemistry of Physiologically Active Compounds of the USSR Academy of Sciences examined and approved the proposals on long-term scientific trends connected with an increase in agricultural production, which are to be developed in the institutes of this department.

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AGROTECHNOLOGY

GREATER CONTRIBUTION OF SCIENCE TO AGRICULTURE URGED

Moscow IZVESTIYA AKADEMII NAUK SSSR-SERIYA BIOLOGICHESKAYA in Russian No 3, 1979 pp 473-474

[Report on general meeting of the USSR Academy of Sciences by Samsonov, S. K.: "General Meeting of the USSR Academy of Sciences 'Science for Agriculture'"]

[Text] The session of the general meeting of the USSR Academy of Sciences held in Moscow on 6-7 December 1978 was devoted to an increase in the role of science in the fulfillment of the tasks facing agriculture.

Opening the first meeting, academician A. P. Aleksandrov, president of the USSR Academy of Sciences, defined the basic task of the session in the elaboration of an overall program for the development of work for the needs of agriculture. It will have to be fulfilled by the joint efforts of the scientists of the USSR Academy of Sciences, VASKhNIL [All-Union Academy of Agricultural Sciences imeni V. I. Lenin] and sectorial institutes.

USSR Minister of Agriculture V. K. Mesyats presented the report "Urgent Tasks in USSR Agriculture at the Present Stage." Having described the significant advances of socialist agriculture made as a result of the implementation of the agrarian policy of the CPSU developed by the March (1965) Plenum of the CPSU Central Committee, subsequent plenums of the Central Committee and congresses of the Leninist Party, the speaker noted the significant contribution of science to the cause of solution of agricultural problems.

V. K. Mesyats discussed in detail a number of the most urgent problems, in the overall solution of which the active participation of the scientific institutions of the USSR Academy of Sciences and other departments is necessary. The protection of land and of the natural resources of our environment should be in the center of attention of scientists. A number of no less urgent problems deserve the close attention of agrarian economists.

Academician Yu. A. Ovchinnikov, vice-president of the USSR Academy of Sciences, presented the report "Fundamental Sciences for Agriculture." Fulfilling the order of the Communist Party and the Soviet State, the scientific institutions of the USSR Academy of Sciences and of the academies of sciences of the Union

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republics actively contribute to the progress of agricultural production. However, as the speaker noted, the new tasks set for agriculture require for their solution a more active participation of academic institutes. Yu. A. Ovchinnikov dwelled on a number of especially important problems, to the solution of which the USSR Academy of Sciences can and should make its significant contribution. In conclusion he discussed the need for sharply increasing the attention of academic institutions to scientific and technical progress in agriculture and in connection with this for specifying the subjects of research and the periods of its fulfillment and for strengthening the base of all the institutes participating in this.

P. P. Vavilov, president of VASKhNIL, was given the floor for the report "Tasks of Agricultural Science in the Light of the Decisions of the July (1978) Plenum of the CPSU Central Committee." Dwelling in detail on the most significant achievements of agricultural science, the speaker touched upon problems whose elaboration especially requires a full interaction and efficiently organized creative cooperation. The preparation of joint programs under the auspices of interdepartmental councils and commissions serves as an efficient method of organizing an interacademic interaction.

In his joint report academician Ye. N. Mishustin, chairman of the Commission on the Scientific Basis for Agriculture of the Presidium of the USSR Academy of Sciences, discussed the close connection between the chemicalization of agriculture and increase in the yield of cultivated plants. The supply of nitrogen for agriculture, in which biology can provide significant help to the chemical industry, is especially important. Owing to the biological fixation of the molecular nitrogen of the atmosphere by symbiotic microorganisms living in the plant root system, it is transformed into the protein of the harvest and, partially, into soil nitrogen. Pod-bearing crops, which under favorable conditions fix a great deal of molecular nitrogen, are used on an especially wide scale for this purpose. According to the available data, pod-bearing plants fix 3 million tons of nitrogen, of which more than one-half are used by the following crops. A total of 15 to 20 kg of nitrogen per hectare are annually assimilated by free-living microorganisms. In the country this totals up to 4.5 million tons, which are also transformed into organic nitrogen. Thus, biological nitrogen can be very effectively used for the purpose of increasing soil fertility.

In his joint report academician S. I. Vol'fkovich said that the further development of chemicalization of agriculture required significant rationalization in the extraction of natural raw material resources and in the production and consumption of mineral fertilizers. He also noted the urgent need for the development of work on hydroponics and hothouse facilities--the distinctive "virgin land" whose development is possible and advisable in desert and mountain regions and beyond the polar circle, where, for all practical purposes, ordinary farming is absent. The scientific theoretical base for chemical plant protection needs a significant improvement. This group of investigations requires an immediate expansion and intensification.

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The joint report by G. K. Skryabin, corresponding member of the USSR Academy of Sciences, was devoted to the microbiological basis for obtaining protein and physiologically active substances for the needs of livestock breeding. The first large-capacity production of fodder yeast based on normal alkanes isolated from petroleum in the world was established in the Soviet Union. Hundreds of thousands of tons of fodder protein are now produced. Chemical hydrolyzates of timber and other cellulose containing materials serve as the second type of raw materials, which are also used for the production of fodder yeast. The development of large-capacity production on this basis is hampered by the lack of techniques for a continuous chemical hydrolysis of timber. The development of the process of enzymatic hydrolysis of cellulose containing materials has become the most important task of scientists.

Ethyl and methyl alcohols are excellent substrates for yeast growing. Yeast grown on ethanol is the most nutritive and harmless. Ethanol can also be considered a substrate suitable for the production of protein containing additives for human food.

Among other promising types of raw materials for the large-capacity production of microbiological protein the speaker mentioned hydrogen and methane. Methane oxidizing, hydrogen and some other bacteria can prove to be even more effective than yeast, because these microorganisms contain an even greater amount of protein.

Academician P. N. Fedoseyev, vice-president of the USSR Academy of Sciences, also made a report. Then the debate began.

The next day of the session's work opened with a report by academician A. V. Sidorenko, vice-president of the USSR Academy of Sciences, "Earth Sciences for Agriculture." The speaker talked about the limitedness of land resources suitable for farming and about the need for their efficient use and protection. The scientists of the USSR Academy of Sciences made an important contribution to the establishment of the raw material base for the production of mineral fertilizers. Overall investigations connected with the problem of transferring the rivers of the northern runoff to arid regions in the south and of the ways of more efficiently utilizing the available water for irrigation are now conducted.

A debate followed the report by academician A. V. Sidorenko, in which many of our country's leading scientists participated.

Yu. A. Izrael', corresponding member of the USSR Academy of Sciences, discussed the direct dependence of the productivity of agriculture on the state of the natural environment and on the degree of its pollution.

The speech by academician A. L. Kursanov was devoted to the leading role of plant physiology--biological discipline closest to the problems of practical plant growing--and to the importance of the work of the Institute of Plant Physiology of the USSR Academy of Sciences for an increase in the productivity of agriculture.

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Using a number of examples, academician N. V. Tsitsyn convincingly showed the wide possibilities of breeding and genetic science, which is now capable of solving serious and important tasks connected with the transformation of the nature of plants.

Academician M. S. Gilyarov discussed the need for a profound ecologophysiological investigation of the pest insects of cultivated plants, their entomophages and other insects used by useful entomophages for their food and development.

Academician A. A. Bayev noted the rationality of obtaining fodder protein and the necessary amino acids, vitamins and other biological stimulators as a result of the use of microorganisms. However, by means of genetic engineering it is possible to develop microorganisms--superproducers of the necessary compounds through the colonization of the microbe cell with the appropriate genes. No less wide a field of application of the methods of genetic engineering can be in the area of biological fixation of nitrogen. Work on the development of symbiotic bacteria with grasses, sunflowers and other cultivated plants not having their own bacteria--nitrogen suppliers--has already begun. Genetic research at the level of cells--hydrolyzation of unrelated cells overcoming barriers created by nature for the prevention of the fusion of species--opens up new prospects. It becomes possible to create a vast world of new organisms, which will become the exclusive creation of man.

The other speeches were also very interesting and meaningful.

After the concluding speech by academician A. P. Aleksandrov, president of the USSR Academy of Sciences, the floor was given to academician Yu. A. Ovchinnikov for a report on the draft resolution.

The session of the general meeting of the USSR Academy of Sciences ended with the adoption of an appeal to scientists and all workers of the USSR Academy of Sciences, academies of sciences of the Union republics, higher schools, scientific institutions, ministries and departments. It contains a call to more closely connect their work with the solution of scientific and technical problems connected with the development of agriculture.

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AGROTECHNOLOGY

A CONSTANT VOLUME METHOD FOR THE OPERATION OF REMOTE CONTROLLED CANALS

Moscow DOKLADY VSESOYUZHNOY ordena LENINA AKADEMII SEL'SKOKHOZYAYSTVENNYKH
NAUK imeni V.I. LENINA in Russian No 10, 1978 pp 40-41

Article by V.S. Prokop'yev, Rastovskaya Oblast Administration of Land
Development and Water Management

Text One of the main problems in automating and introducing remote control to water distribution in irrigation canals is the selection of a regulation method. Technical improvement of irrigation systems and the introduction of methods for automatic and remote control have enabled expansion of the known classical methods for automating water distribution (1). The use of a particular scheme is determined by the desire to achieve a certain effect through its introduction.

The proposed "constant volume scheme can be realized in remote controlled canals, i.e. in the case of centralized regulation of the systems. In this scheme water distribution is regulated by maintaining a constant volume of water between two partitioning structures in all modes of canal operation.

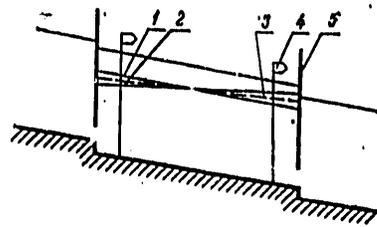
This means that the algebraic sum of the water flows entering the canal and exiting from it must be equal to zero. Thus, a change of water flow at any structure must lead to manipulation of the upstream partitioning structures up to the head structure inclusively.

Lines of the free water surface for regulation by this method are shown in figure 1. The distance between the partitioning structures and the slope of the canal bottom in this case must control the water levels--in the upper part given a minimal flow rate and in the lower part when the flow rate is maximal.

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Figure 1. Lines of the free water surface for regulation by the "constant volume" method



- 1 -- given Q_{max}'
- 2 -- when $Q=0$
- 3 -- when $0 < Q < Q_{max}'$
- 4 -- water outlet
- 5 -- partitioning structure

Since the flow at the partitioning structures depends on the total flow of under water and the water level in the canal changes, the flow at the water outlets also changes. In this consists all the complexity of regulation by the "constant volume" method.

The discussed method is theoretically sound for use on the upper water of the Proletarskiy branch of the Donskoy main canal in Rostovskaya Oblast.

Transient operation in the upper water of this canal was evaluated by the method of E. E. Makovskiy (3). In conformance with this method the change of gate opening at the head and partitioning structures was taken as the regulating action.

The dependence of the change of relative stead-state flow rate q at a structure on the relative gate opening a is shown in figure 2.

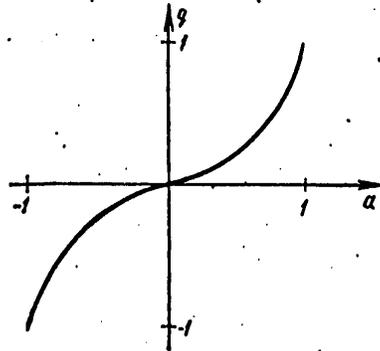


Figure 2. The function $q=f(a)$

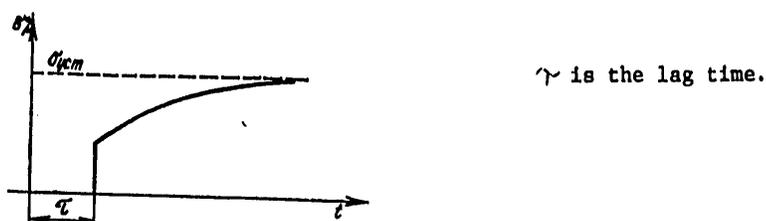
The scheme of regulation by the "constant volume" method for a canal section is the following: determination of the change of total required upper water flow- determination of the required change of low at the partitioning structure- determination of the required change of the gate opening at the partitioning structure (figure 2)- simultaneous change of the gate opening at the partitioning and regulated water outlet structure.

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The characteristic change of flow rates at the water outlets as a result of the transient process is shown in figure 3, where the sign of the deviation is different for the water outlets of the first and second halves of the canal section.

Figure 3. The change of relative flow rate at the water outlets (percent δ) during the transient process



If the value of the determined flow rate change is within permissible limits, then the process is accomplished by changing the gate opening on the structures. Otherwise it is necessary to periodically correct the flow at the structures.

As calculations show, for the majority of water outlets of the upper waters of the Proletarskiy canal the values of flow deviation are within a 5 percent zone for a wide range of regulatory action (up to 5.0 m³/s), and correction is not required in this case.

In addition, to prevent overflowing of the canal it is necessary to check the dry margin of the partitioning structures on the upper waters when there is no discharge.

Use of the discussed method for remote control of water distribution enables a reduction of forced technological water discharge. It is important to note that when water is taken from open sources or when an older canal is operated by the "constant volume" system the described method allows the distribution of water "according to demand", that is each consumer can at any time begin to draw water from the canal and at any time refuse it.

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AGROTECHNOLOGY

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THE BIOLOGICAL VALUE OF GRAIN CULTIVATED WITH THE USE OF HERBICIDES

Moscow DOKLADY VSESOYUZHNOY ordena LENINA AKADEMII SEL'SKOKHOZYAYSTVENNYKH
NAUK imeni V. I. LENINA in Russian No 10, 1978, pp 20-22

Article by Candidate of Biological Sciences L. G. Gruzdev, Candidate of
Agricultural Sciences M. S. Rackin and Candidate of Medical Science A. V.
Fomin

Text It was shown previously that many herbicides to some extent change
the chemical composition of plants and the individual indicators of crop
quality (1-3, 5). Continuing work in this direction we studied certain
indicators of the biological value of oat variety Chernigovskiy 83 when
cultivated with the use of herbicides 2, 4-D, dialen, diamet-D and diamet-D
with chloramp. In field experiments at the Zhitomirskiy Agricultural
Experimental Station a crop was sprayed with herbicides in the doses listed
in the table with a 400 l/ha rate of liquid discharge.

The standard methods for analyzing plant amino acids were used (4).
Residual herbicides were detected by gas chromatography with a sensitivity
of 0.1 mg/kg for 2,4-D and 0.05 mg/kg for dianat. The biological value of
the grain was studied by feeding it (without restriction) to white rats for
4 weeks. In addition the edibility of the feed, the relative masses of the
animals' organs and the fat content of the liver were studied.

The results of the studies showed that the applied herbicides did not
significantly affect the wet and dry mass of oats gathered or their appearance.
Only plants receiving the maximum (experimental) dose (1.8 kg/ha) of dialen
were inhibited; their mass was reduced by 20 percent in 7 days and by 50
percent after 60 days in comparison with the control. All the applied
herbicides considerably decreased the weediness of the oat crops (table 1),
and as a result the yield increased.

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Table 1. The effect of herbicides on weediness and oat yield (1 month after treatment)

(1) Вариант	(2) Доза (кг/га д. в.)	(3) Снижение засоренности (% к контролю)			(4) Урожай зерна		
		(5) всего	(6) в том числе		(9) общий (ц/га)	(10) разница с контро- лем (ц/га)	(11) % к конт- ролю
			(7) чувствитель- ные к 2,4-Д	(8) устойчи- вые к 2,4-Д			
(12) Контроль* (шт/м²)	—	82	21	57	36,1	—	100
(13) 2,4-Д	0,9	63	90	60	34,4	-1,7	96
(14) Диамет-Д	0,9	77	90	68	40,8	+4,7	113
(15) Дялен	0,7	83	100	84	40,2	+4,1	111
"	0,9	93	100	93	38,4	+2,7	106
"	1,8	93	100	93	35,2	-0,9	98
(16) Диамет-Д + хлорамп	0,9	100	100	100	23,6	-12,5	66
НСР ₀₅ (ц/га)		72	86	76	37,7	+1,6	104
					2,6		

Key:

- | | |
|---|--|
| 1. Variation | 9. Total (c/ha) |
| 2. Dose (kg/ha) | 10. Difference from the control (c/ha) |
| 3. Reduction of weediness
(percent of control) | 11. Percent relative to the control |
| 4. Grain yield | 12. Control |
| 5. Total | 13. 2,4-D |
| 6. Of those | 14. Diamet-D |
| 7. Sensitive to 2,4-D | 15. Dialen |
| 8. Resistant to 2,4-D | 16. Diamet-D + chloramp |

Analysis of the residual amount of herbicides in the vegetational mass of the plants showed that the amine salt 2,4-D was completely decomposed in them 30-35 days after treatment (table 2). Dialen in doses of 0.7 and 0.9 kg/ha was not detected after 40-60 days and in a dose of 1.8 kg/ha was present in trace amounts at the end of the vegetational period. Residues of these herbicides applied in doses of .7 and .9 kg/ha were not detected in the grain.

Table 2. Residual amounts of herbicides in oat plants (mg/kg dry weight)

(1) Вариант	(2) Доза (кг/га д. в.)	(3) Дни отбора растений после внесения гербицидов						
		1	7	14	21	30	60	75
(4) 2,4-Д	0,9	120	29	7	5,5	следы	0	0
(5) Дялен	0,7	90+7,5	26+3	9+0,7	4+0,5	следы	0	0
"	0,9	100+12	32+7	12+2,0	5+0,6	1,5+0,2	0,5+0,1	0
"	1,8	220+25	130+16	37+9,0	13+6,0	7+1,4	1,5+0,05	следы

Note -- the first figure is for 2,4-D, the second is for dianat.

Key:

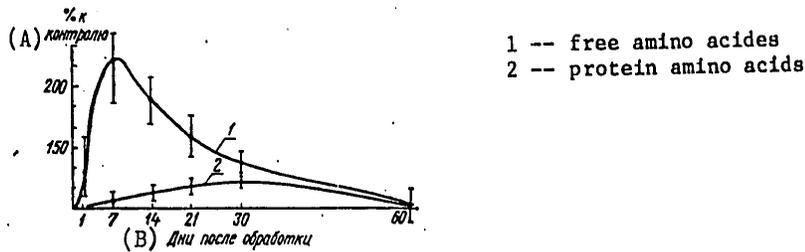
- | | |
|--|-----------|
| 1. Variation | 4. 2, 4-D |
| 2. Dose (kg/ha) | 5. Dialen |
| 3. Days after herbicide application
of plant sampling | 19 |

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The use of herbicides led to significant changes in the amino acid composition of the vegetational mass of the oat plants. This especially pertains to amides, asparaginic, glutamic and γ -aminobutyric acids and alanine in a free state. As the residual amounts of herbicides in the plant vegetational mass decreased, the amino acid composition of the vegetational mass became almost identical to the control. At the same time changes in the amino acid composition of proteins increased, reaching a peak at the middle of the vegetational period and, towards the end of it, becoming equal with the control. This probably indicates that the variations recorded lie within the limits of normal plant metabolic reactions under changing growth conditions. The change of the amino acid composition of the oat vegetational mass is shown in the figure.

Changes of the amino acid composition of oat plants after the application of herbicides



Key:

- A. Control
- B. Days after treatment

We did not detect significant differences in the amino acid composition of the grain. This agrees with data obtained previously (1, 5).

Biological studies with rats showed that the animals which received control and experimental samples (the herbicide dose was 0.9 kg/ha) did not significantly differ in live weight at the end of the four week observation period (table 3). The negligible inhibition of growth in the animals which received grain cultivated with dialen and diamet-D is associated with a decreased edibility of these grain types. Thus, the amount of control grain consumed by rats during the 4 week period was 2006 g, and the amount of grain cultivated with the application of ialen, diamet-D and diamet-D with chloramp was 1926, 1924 and 1928 g respectively.

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Table 3. The weight of animals which received grain cultivated with the use of herbicides (g, M±m)

(1) Вариант	(2) Опыт			(6) Масса к началу месяца (%)	(7) Прирост массы (г)	(8) Корма на 1 г при- роста (г)
	(3) начало	(4) середина	(5) конец			
(9) Контроль	128,0 ± 6,5	146,9 ± 6,7	159,7 ± 8,6	124,7	31,7	63,2
(10) Диален	126,3 ± 5,1	138,5 ± 6,9	150,9 ± 8,2	119,4	24,6	78,3
(11) Диамет-Д	128,0 ± 6,1	145,1 ± 4,4	153,0 ± 3,6	119,5	25,0	76,9
(12) Диамет-Д + хлорамп	127,9 ± 6,9	138,2 ± 7,4	157,6 ± 8,0	121,6	29,7	64,0

Key:

- | | |
|--|-------------------------------|
| 1. Variation | 7. Mass increase (g) |
| 2. Experiment | 8. Feed per 1 g of growth (g) |
| 3. Beginning | 9. Control |
| 4. Middle | 10. Dialen |
| 5. End | 11. Diamet-D |
| 6. Mass relative to initial mass (percent) | 12. Diamet-D + chloramp |

The mass ratios of the liver, heart and testicles for animals of all the groups did not differ significantly (table 4). The relative mass of the kidneys differed somewhat from the control only in the group of animals which received grain cultivated with dialen. A small increase of the spleen mass ratios in animals which received grain cultivated with herbicides was probably not significant.

Table 4. Mass ratios of the animal organs

(1) Вариант	(2) Печень	(3) Почки	(4) Сердце	(5) Селезенка	(6) Семенники
(7) Контроль	3,98 ± 0,26	0,67 ± 0,02	0,34 ± 0,01	0,46 ± 0,05	1,05 ± 0,09
(8) Диален	3,92 ± 0,29	0,74 ± 0,02	0,35 ± 0,01	0,58 ± 0,10	1,09 ± 0,10
(9) Диамет-Д	3,79 ± 0,33	0,69 ± 0,04	0,35 ± 0,01	0,60 ± 0,08	0,89 ± 0,07
(10) Диамет-Д + хлорамп	3,77 ± 0,16	0,70 ± 0,02	0,31 ± 0,01	0,44 ± 0,06	1,18 ± 0,10

Key:

- | | |
|--------------|-------------------------|
| 1. Variation | 6. Testicles |
| 2. Liver | 7. Control |
| 3. Kidneys | 8. Dialen |
| 4. Heart | 9. Diamet-D |
| 5. Spleen | 10. Diamet-D + chloramp |

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The amount of liver fat in the animals was determined by extraction from an anhydrous suspension. It was found to be 10.0 percent in the control animals, and in the rats which received grain cultivated with dialen, diamet-D and diamet-D with chloramp it was 9.4, 8.7 and 7.5 percent respectively.

Thus, use of the herbicides dialen and diamet-D in the recommended doses on oat crops substantially effects the amino acid composition of the plants in the vegetational period, but within the limits of normal metabolic reaction, which confirms the production of a crop with an unchanged chemical composition and without residual amounts of the preparations used. At the same time some reduction of the edibility by white rats of grain cultivated with herbicides is observed. This may be related to the presence of some metabolites of the herbicides which imperceptibly deteriorate individual organoleptic indicators.

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AGROTECHNOLOGY

UDC 633.11"321"(470.40/.43)

THE BEST SHORT-STEMMED SPRING WHEATS OF THE WORLD COLLECTION OF THE ALL-UNION SCIENTIFIC RESEARCH INSTITUTE OF PLANT GROWING AND THE PROSPECTS FOR THEIR INTRODUCTION IN THE IRRIGATED LANDS ALONG THE MIDDLE VOLGA

Moscow DOKLADY VSESOUZNOY ordena LENINA AKADEMII SEL'SKOKHOZYAYSTVENNYKH NAUK imeni V. I. LENINA in Russian No 10, 1978 pp 9-11

Article by Candidate of Agricultural Sciences A. M. Medvedev

Text For the production of high yields of soft wheat in irrigated areas or in regions with sufficient precipitation it is necessary to have standing, intensive varieties with a potential productivity of 60-70 c/ha high quality grain.

During 12 years at the Kinel'skiy support point of the Kuybyshevskaya Oblast All-Union Scientific Research Institute of Plant Growing we studied over 15 thousand types of spring wheat from 80 countries of the world under irrigated and non-irrigated conditions. In summary it can be concluded that varieties with sufficiently long stems possessing high resistance to drought and increased air temperatures can be cultivated in large tracts along the Middle Volga without the use of irrigation. We found a positive correlation between the stem height, drought resistance and productivity of the wheat.

Under conditions of irrigation the greatest yields (45-50 c/ha) during 1967-1977 were obtained when the best short-stemmed varieties were cultivated. Long-stemmed varieties produced grain yields up to 40 c/ha. However, among the short-stemmed wheats there are also varieties which gave low yields.

Good sources of stock for creating varieties for use in irrigated fields are the short-stemmed, brown rust resistant, high quality wheats Nadadores 63, Nainari 60, Tobar 66, Norteno 67 and the complex hybrids with introduction numbers 321552, 321676, 321890, 309552 and 309944 from Mexico; hybrid 8156 (R) from the USA; the Peruvian complex hybrids with introduction numbers 309970, 309971, 309944, 309975 and 309983; the Chilean hybrids with catalog numbers 46490, 46520, 46522 and 46523; the Indian hybrids Kalyan Sona, Sharbati Sonora and Sona 227; and Rode (k-45020) from Kenya.

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Several of these varieties--Sona 227, Kalyan Sona and Tobari 66--transmit their favorable characteristics when crossed with Volga varieties. For example, when Saratovskaya 36 was crossed with Sona 227 we obtained a number of lines with high resistance to blights and lodging and with sufficient adaptableness to local pest flora and to increased temperatures.

Highly productive types of soft spring wheat were developed at the Kyubyshevskiy Scientific Research Institute of Agriculture, the Kine'lskiy State Plant Breeding Station and other institutions (Samarskiy, Kutulukskiy, Komsomolka and Bezenchukskiy 140) by breeding with the short-stemmed varieties from Mexico, the United States and India.

On the basis of our experiments we came to the conclusion that in irrigated fields with sufficient application of fertilizers a short-stemmed wheat should be used, but with longer stems in the range of 75-90 cm. A further decrease of the height, for various reasons, causes reduced productivity. On the other hand, tall stems (over 100 cm) do not provide resistance to lodging, which also reduces the yield and quality.

In the opinion of V. A. Kumakova (1) under conditions of irrigation an early ripening spring wheat of the "green broilers" type should be cultivated so that the land can be used for multiple crops. This is quite true. Nevertheless, our observations show that the highest wheat yields are obtained when a short-stemmed variety of the midseason maturing type is used. In this respect the Mexican variety Siente Cerros 66 and the Indian Kalyan Sona are examples. They are close to Saratovskaya 36 in vegetational period length. A significant shortening of the vegetational period cannot help but affect plant productivity (2).

The unfavorable characteristics of many short-stemmed varieties from the world collection of the All-Union Scientific Research Institute of Plant Growing are a weak survival rate and insufficient resistance to adverse environmental factors: aerial, drought, sharp temperature changes, hot weather, diseases and pests. They are particularly sensitive to Swedish, Hessian and spring flies and also to grain sawflies. We noted a positive correlation between stem diameter and the damage to wheat by grain sawflies. The Canadian tall-stemmed soft wheats S₁₀ a B₃ and S₁₀ b B₃, which are resistant to lodging because of their larger stem diameter, during a number of years were up to 50 percent damaged by these insects.

The advantage of regional types of Saratovskaya breeding is a high resistance to intracaulous pests and grain sawflies. This places them among the most valuable varieties for breeding.

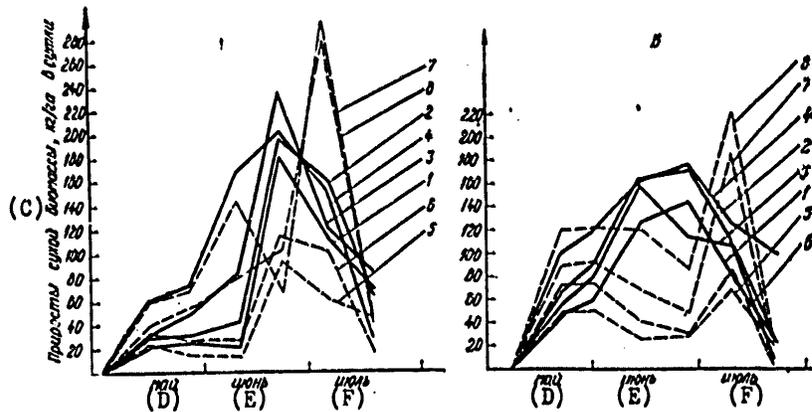
Undoubtedly, short-stemmed varieties which are resistant to pests and other adverse environmental conditions can be created by drawing local varieties into interbreeding. On the other hand, it is unthinkable to breed blight and lodging resistant types without utilizing resistant varieties from other countries.

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According to our observations the ratio of grain mass to straw mass for short-stemmed wheats is 1:1 or even 1:0.8. This biological characteristic should be considered when growing similar varieties. While in tall-stemmed wheats the maximum consumption of moisture and nutritive substances and the maximum accumulation of dry substance occurs in the period of stem extension (the heading stage), in short-stemmed varieties this maximum "moves" into the period of grain formation. Over a short period of time after flowering (10-12 days) short-stemmed plants during grain formation accumulate almost as much dry substance as during all of the previous vegetational period.

This is confirmed by data we obtained during 1972-1974 in a study of the photosynthetic activity of tall and short-stemmed varieties (figures 1 and 2). Taking into account the similar characteristic of short-stemmed wheats it is possible to significantly increase (by 25-30 percent) their productivity by applying mineral fertilizers (N₆₀P₆₀K₆₀) through the grain formation period in combination with irrigation.

Figure 1. Daily growth of the dry mass of spring wheat during vegetation:
A-- 1972, B -- 1973



Tall-stemmed Saratovskaya 36: 1 -- control, unirrigated land; 2-- N₁₂₀P₁₂₀K₁₂₀, unirrigated land; 3 -- control, irrigation; 4 -- N₁₂₀P₁₂₀K₁₂₀, irrigation.
Short-stemmed Siete Cerros 66: 5 -- control, unirrigated land; 6 -- N₁₂₀P₁₂₀K₁₂₀, unirrigated land; 7 -- control, irrigation; 8 -- N₁₂₀P₁₂₀K₁₂₀, irrigation.

Key:
C. Growth of the dry biomass (kg/ha per day)
D. May
E. June
F. July

Usually, when long-stemmed varieties are grown fertilization and irrigation in the late vegetational period causes extensive lodging of the crops. With short-stemmed wheats this phenomenon is almost eliminated, and fertilization

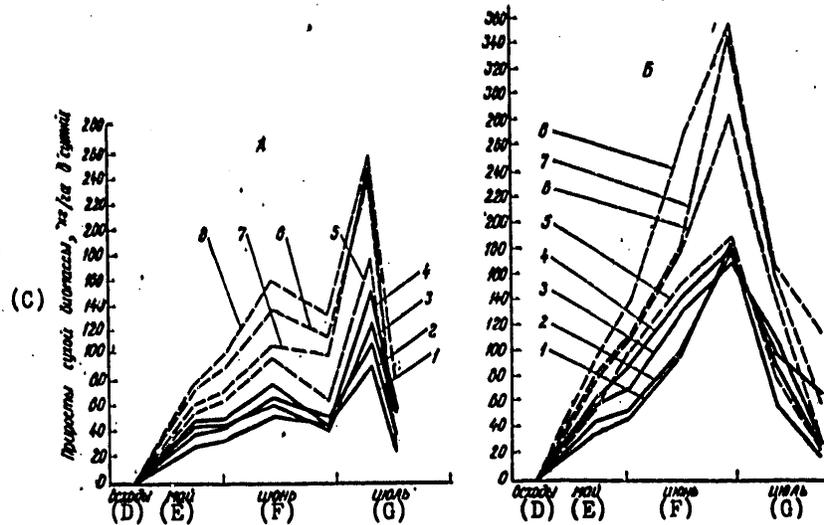
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causes a considerable increase of the mass of 1000 grains and the survival rate of the plants. As a result the yield is significantly increased (see table).

In our opinion this biological characteristic of short-stemmed wheats should be considered when evaluating breeding stock.

Figure 2. Daily growth of the dry mass of spring hard wheat during vegetation in 1973: A -- USMP-13, B -- Khar'kovskaya 46



Unirrigated land: 1 -- control, 2 -- $N_{60}P_{60}K_{60}$, 3 -- $N_{120}P_{120}K_{120}$, 4 -- $N_{180}P_{180}K_{180}$; irrigation: 5 -- control, 6 -- $N_{60}P_{60}K_{60}$, 7 -- $N_{120}P_{120}K_{120}$, 8 -- $N_{180}P_{180}K_{180}$

Key:

- C. Growth of the dry biomass (kg/ha per day)
- D. Seedlings
- E. May
- F. June
- G. July

In Kuybyshevskaya Oblast each year spring wheat is grown with irrigation on an area of 5 thousand hectares. Evidently, with the use of herbicides, fertilizers and corresponding agricultural practices including increased seeding it is possible to harvest no less than 40-45 c/ha of grain on this area rather than the 22-25 c/ha presently obtained with tall-stemmed varieties.

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The effect of split application of fertilizers on the yield (c/ha) of spring wheat under conditions of irrigation

(1) Сорт	(2) N ₁₈₀ P ₁₈₀ K ₁₈₀ под глубокую предпосевную культивацию			(3) N ₁₂₀ P ₁₂₀ K ₁₂₀ под культивацию + N ₆₀ P ₆₀ K ₆₀ в подкормку		
	1975 год (4)	1976 год (5)	среднее (6)	1975 год (4)	1976 год (5)	среднее (6)
(7) Мягкая пшеница						
{8} Саратовская 36	30,5	27,9	29,2	34,3	30,7	32,5
{9} Кинельская 30	32,1	29,7	30,9	36,8	33,8	35,3
{10} Сiente Cerros 66	33,8	46,3	40,1	40,9	56,7	48,8
{11} Тобари 66	35,9	44,8	40,4	44,2	56,7	49,5
(12) Твердая пшеница						
{13} Харьковская 46	31,7	32,4	32,1	32,7	33,8	33,3
{14} УСМП-13	32,7	40,5	36,6	40,5	50,8	45,6
m (%)	I II = 2,71					
НСР _{п.05} (ц/га)	I II = 1,15					

Key:

- | | |
|--|----------------------|
| 1. Variety | 6. Average |
| 2. N ₁₈₀ P ₁₈₀ K ₁₈₀ under deep presowing cultivation | 7. Soft wheat |
| 3. N ₁₂₀ P ₁₂₀ K ₁₂₀ under cultivation + N ₆₀ P ₆₀ K ₆₀ in supplementary fertilization | 8. Saratovskaya 36 |
| 4. 1975 | 9. Kinel'skaya 30 |
| 5. 1976 | 10. Siente Cerros 66 |
| | 11. Tobar 66 |
| | 12. Hard wheat |
| | 13. Khar'kovskaya 46 |
| | 14. USMP-13 |

In Krasnodarskiy Kray, Volgogradskaya Oblast and Saratovskaya Oblast the foreign varieties Siente Cerros 66, Kalyan Sona and B. J. 1877 have been regionalized. With irrigation and proper agricultural practices they can produce grain yields of 40-45 c/ha. This has been shown by experiments of the Kuybyshevskiy Scientific Research Institute of Agriculture and the Volzhskiy Scientific Research Institute, by our studies and by industrial experiments of several kolkhozes and sovkhoses along the Volga.

Presently nonregionalized foreign soft short-stemmed varieties with high adaptableness to local conditions can be used in certain zones to increase the yield of irrigated hectares.

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UTILIZATION OF A NUMERICAL MODEL FOR PREDICTING THE EFFECT OF WATER-ENGINEERING RECLAMATION ON SOIL MOISTURE

Moscow DOKLADY VSESOYUZNOY ordena LENINA AKADEMII SEL'SKOKHOZYAYSTEVENNYKH NAUK imeni V. I. LENINA in Russian No 10, 1978 pp 17-19

Article by Candidates of Biological Sciences T. A. Romanov and G. A. Pisetskiy and Candidates of Agricultural Sciences T. N. Puchkareva and Z. A. Kapilevich, Belorussian Scientific Research Institute of Soil Science and Agricultural Chemistry

Text The scale of contemporary water-engineering land development requires the prediction of the effect of drainage on the complex nature of soils. The development of a numerical model for simulating the change of soil moisture caused by drainage can serve as a basis for such prediction without requiring expensive and difficult to organize experiments. Particularly important is the prediction of the effect of drainage on the ground water regime in European alluvial plains, where soils with varying moisture contents developed by loose soil-forming rocks form complex combinations (4). The effect of drainage in such combinations spreads over large distances and is usually difficult to predict.

We constructed a mathematical model of soil combinations in the Belorussian Poles'ye based on a representation of the functional relations between the moisture content in the upper layers of each soil type and the ground water level.

In developing the model we used the results of studies of the ground water regime (5) and the composition of the soil covering in the Polesie (4) which led to the following conclusions.

I. Soils with different moisture contents (gleyed beneath, temporarily excessively moistened, gleyey and gley) (2) are characterized by distinctive moisture regimes which can be expressed as an average over many years of the number of days per vegetational period (per year) during which the moisture content in the upper 20 cm layer exceeds the maximum field water capacity (MPWC). Soil moisture parameters for the Belorussian Poles'ye are presented in table 1. The relations between the moisture contents and the periods

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with the various soil moistures are described by equations (1-3):

$$t_1 = 29,8 + 1,812x - 0,009x^2; \quad (1)$$

$$t_2 = -3,93 + 0,365x + 0,0023x^2; \quad (2)$$

$$t_3 = 737,075x - 0,13x - 359,218, \quad (3)$$

where x is the moisture content in the 0-20 cm layer; t₁, t₂ and t₃ are the number of days with moisture content in the ranges: t₁ -- MFCW-MCD, t₂ -- FWC-MFCW, t₃ -- MCD-MW; FWC is the full water capacity, MFCW is the maximum field water capacity, MCD is the moisture of capillary disruption and MW is the moisture of wilting (3).

II. There is a functional relation between the moisture stored in the 0-20 cm layer and the depth (level) of ground waters (GWL) which was determined by simultaneous measurement of the moisture in soils with different moisture contents and the GWL of each soil (figure 1). This empirical relation is given approximately by the equation:

$$y = -4,875 + \frac{85,344}{x} + \frac{1,994}{x^2}, \quad (4)$$

where y is the total moisture (mm) stored in the 0-20 cm layer and x is the GWL (m).

Table 1. Quantitative parameters of the moisture of sandy and sandy loam soils in the Belorussian Poles'ye (days) during the vegetational period (months IV-X)

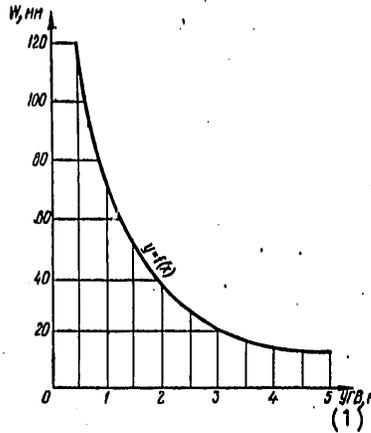
(1) Степень увлажне- ния почв	(2) Число дней с влажностью почв в слое 0-20 см в диапазоне								
	ПВ-ПВВ (3)	ППВ-ВРК (4)	ВРК-ВЗ (5)	ПВ-ПВВ (3)	ППВ-ВРК (4)	ВРК-ВЗ (5)	ПВ-ПВВ (3)	ППВ-ВРК (4)	ВРК-ВЗ (5)
	(6) годы по влажности								
	влажный (7)			средний (8)			сухой (9)		
(10) Автоморфные	—	60	150	—	40	170	—	20	190
(11) Оглеевые внизу	10	100	100	—	60	150	—	40	170
(12) Временно избыточно увлажняемые	40	130	40	10	80	120	—	60	150
(13) Глееватые	110	100	—	50	100	60	20	100	90
(14) Глеевые	160	50	—	120	80	10	60	110	40

Key:

- | | |
|--|---------------------------------------|
| 1. Amount of soil moisture | 8. Moderate |
| 2. The number of days with the soil moisture of the 0-20 cm layer in the range | 9. Dry |
| 3. FWC-MFCW | 10. Automorphic |
| 4. MFCW-MCD | 11. Gleyed beneath |
| 5. MCD-MW | 12. Temporarily excessively moistened |
| 6. Years according to moisture | 13. Gleyey |
| 7. Wet | 14. Gley |

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Figure 1. A generalized mathematical curve showing the relation between moisture stored in the 0-20 cm layer and the ground water level in soils with different moisture contents



Key:

1. GWL (m)

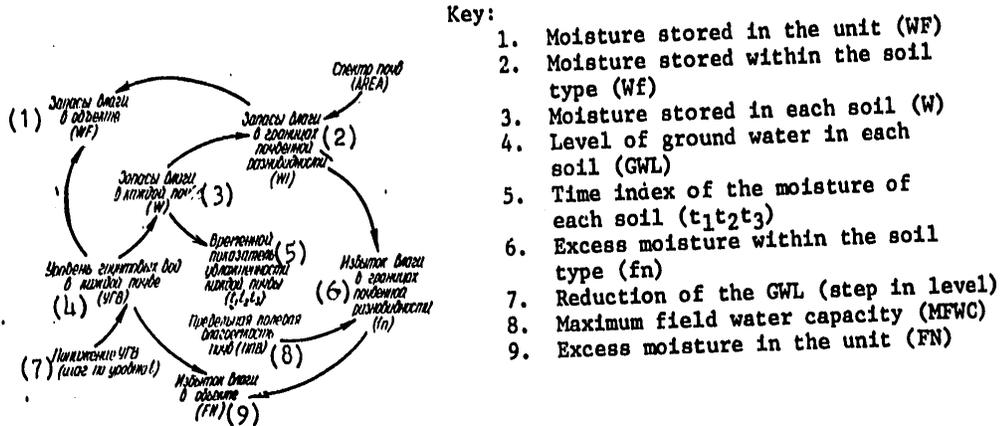
III. Typified soil combinations are natural systems (regularly organized groups) in a state of relative equilibrium (for a given length of time) sustained by a certain GWL. Such a natural system can be described by a functional mathematical model (1). The causal relations of the system are shown in figure 2. The elements of this system (soils) are more closely related than neighboring systems (soil combinations). Correlation-regression analysis (6) showed a close correlation (r from 0177 to 0193) between the water stored in soils with different moisture contents (of the system elements) which indicates a relation of the form $y = ax + b$, where a and b are constants characteristic for a combination of soils with different moisture contents.

Equations (1-4), which agree well with measurements actually observed, form the basis of the mathematical model. The functional approach to organizing the model permitted a representation of the dynamics of the component interactions and the system as a whole. The process of soil moisture change was examined with successive reductions of the GWL by 10 cm (steps in the level). The model was run on an IBM EC-1020 with the use of Fortran -IV.

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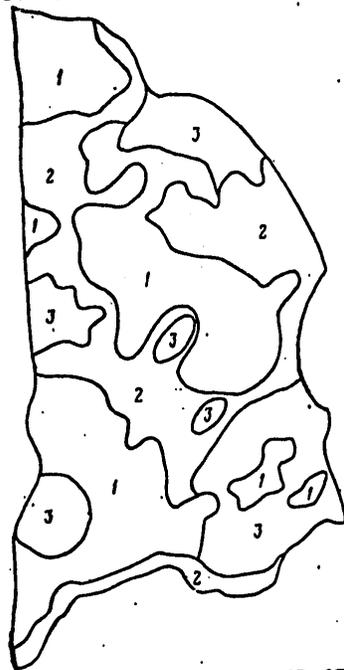
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Figure 2. A diagram of the causal relations used in constructing the functional model of soil combinations



As an example we will discuss the results obtained for modelling of the "Dubovoye" reclamation unit, which is situated on an area of 170 ha in the Luninetskaya Rayon of Brestskaya Oblast. The combination of soils in its boundaries are typical for sandy lowlands with a close GWL in the central region of the Poles'ye (figure 3).

Figure 3. Soils of the "Dubovoye" reclamation unit



Soddy-podzolic swamped sandy soils:

1. Temporarily excessively moistened
2. Gleyey
3. Gley

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For this unit, in addition to the general equations (1-4) specific equations were obtained for the relation between the water stores in the 0-20 cm layer of soils with different moisture contents: between temporarily excessively moistened and gleyey soils

$$y = 0,83 x + 33; (r = 0,89); \quad (5)$$

and between gleyey and gley soils

$$y = 0,92 x + 25; (r = 0,93). \quad (6)$$

Equations (1-6) and the design of the program which simulates the dynamics of moisture in natural systems permit the total moisture of the whole unit and the moisture of each soil separately to be represented in comparable form given any position of the ground water level.

Table 2 shows the changes of soil moisture calculated for a reduction of the GWL at the "Dubovoye" unit. The first 6 lines of the table contain information on the natural moisture of the soils (measurements carried out in July 1970); these are the input parameters of the model. The total moisture stored in the 0-20 cm layer for the whole unit was 11,393 mm, and this corresponds to an excess (FN)* of 3074 mm (a negative value for FN corresponds to a moisture deficiency). The following 6 lines show the change when the GWL is reduced by 10cm in gley soils. With this reduction of the GWL an excess of moisture is retained in the combination as a whole, and drainage is insufficient only in temporarily excessively moistened soils. Further reduction of the GWL leads to a small overall deficiency of moisture in the system and sharp changes of the moisture in individual soils. In this respect a moisture deficiency is observed in gleyey soil. When the position of the GWL is at 100 cm, drainage results in a moisture deficiency (FN=-1152 mm) on the unit as a whole. Thus, when the GWL is reduced by a projected 30 cm for gley soils, the general conditions for plant growth in the unit become worse. Consequently, drainage reclamation of soil combinations similar to the "Dubovoye" unit must be conducted with extreme caution, and every drainage is not suitable for the "Dubovoye" unit--these are typical prairie soils (4). The described method can be applied in any natural regions when the interrelations between the soil moisture and the factors determining it are specified.

In the given example of the simplest logical units of relation--soil moisture (GWL)--was used, and the results of the studies indicate that it is the best. In the future it can be extended and its parameters can be more accurately defined. The model is valuable for describing dynamic natural systems and predicting the changes of soil moisture caused by drainage.

*Excess moisture is conventionally expressed as the number of mm by which the MFWC is exceeded.

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Table 2. The change of soil moisture at the "Dubovoye" unit when the ground water level is reduced (results of calculations)

	Дерново-подзолистые заволаченные песчаные почвы (1)			WF	FN
	временно избыточ- но увлаж- ненные (2)	глеевые (3)	глеи (4)		
УГВ(5)	220	115	70	11 393	3074
wf	2747	3190	5456		
fn	191	577	2306		
t ₁	80	110	90		
t ₂	10	40	100		
t ₃	120	60	20		
УГВ(5)	265	133	80	9665	2412
wf	2207	2732	4227		
fn	-350	110	1568		
t ₁	73	107	100		
t ₂	-	25	80		
t ₃	137	78	30		
УГВ(5)	318	151	90	8290	-30
wf	1768	2359	4193		
fn	-789	-254	1013		
t ₁	68	101	108		
t ₂	-	4	57		
t ₃	144	105	45		
УГВ(5)	383	172	100	7169	-1152
wf	1404	2050	3715		
fn	-1153	-363	565		
t ₁	59	94	100		
t ₂	-	-	40		
t ₃	151	116	70		

Notes -- GWL is in cm, wf is the moisture (mm) stored in the 0-20 cm layer within a soil type, WF is the moisture (mm) stored in the 0-20 cm layer of the entire unit, fn is the excess moisture (mm) in the 0-20 cm layer within a soil type, FN is the excess moisture (mm) in the 0-20 cm layer of the entire unit.

Periods (days) with soil moisture in the ranges: t₁ -- MFWC-MCD, t₂ -- MFWC--FWC, t₃ --MCD-MW.

Key:

1. Soddy-podzolic swamped sandy soils
2. Temporarily excessively moistened
3. Gleyey
4. Gley
5. GWL

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MODELLING OF THE PROCESS OF GAS-JET CLEANING OF RECLAMATION CANALS

Moscow DOKLADY VSESOYUZNOY ordena LENINA AKADEMII SEL'SKOKHZYAYSTVENNYKH
NAUK imeni V.I. LENINA in Russian No 10, 1978 pp 37-39

[Article by Candidates of Technical Science N. N. Kremenetskiy, L. I. Badayev
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of Hydraulic Engineering and Land Development]

[Text] Modelling of the process of gas-jet cleaning of canals can be divided
into two stages: modelling of the gas flow and the process of its interaction
with the layer of detritus.

Modelling of the gas flow. Two streams of viscous incompressible fluid are
similar (3) if the following dimensionless numbers are the same for both:

$$\frac{tv}{l}; \frac{v^2}{g \cdot l} = Fr \text{ (the Froude number); } \frac{v \cdot l}{\gamma} = Re \text{ (the Reynolds number);}$$

$$\frac{\Delta P}{\rho \cdot v^2} = Eu \text{ (Euler's number)}$$

where t is time, v is velocity, l is the characteristic dimension, g is the
acceleration of free fall, γ is the kinematic coefficient of viscosity, ΔP
is the pressure and ρ is the mean density.

The criterion $\frac{tv}{l}$ must be observed when unfixed or periodic movement of a
liquid or gas are studied.

It is not always possible for the Froude number and the Reynolds number to
hold simultaneously, but the effect of viscosity becomes less important for
considerable values of Re .

For high speed gas flows it is advisable to observe similarity according to
the Mach number-- $M = \frac{v}{a} = \text{const}$ --(when $M > 0.3$), where a is the speed of
sound in the given gas.

Dimensionless numbers accounting for thermal conductivity properties are
unimportant because of the short time of the jet's action on the detritus
and, therefore, are not presented here.

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To the set of dimensionless numbers (1), (2) and (3) it is necessary to add criteria including gas temperature T_K and density (1):

$$\frac{l}{R \cdot T_K} \text{ or } \frac{\Delta P}{\rho \cdot R \cdot T_K} \text{ and } \frac{m_t}{f \cdot v \cdot \rho}$$

where f is the jet cross section, m_t is the mass flow rate of the gas and R is the gas constant.

Determination of the dimensionless numbers by the method of dimensional analysis. The main parameters characterizing the process are the gas pressure and flow rate, its velocity, density, temperature and properties (the gas constant and viscosity), the mean ground density, particle diameter (d_p), the ground stability characteristics, properties of the lining material (mean density, porosity and durability) and the coefficient of friction of the ground with the lining material (δ).

The effectiveness of canal cleaning is characterized by the specific volume of detritus removed, and it depends on the angle of the jet, the removal of the jet from the surface of the detritus and the time (t) which the jet acts on the ground.

The interrelation between the listed variables can be represented in general form by the equation

$$f(1, \Delta P, \rho, \gamma, v, T_K, R, \rho_{gr}, d_p, \phi, \delta, g, n_1, \sigma_1, t, \alpha, m_t, \delta) = 0 \quad (4)$$

We shall eliminate 4 basic dimensional quantities-- ΔP , t , l and T_K --from equation (4), defining the remaining 14 values in terms of N_1 , and we define its dimensionality in terms of the dimensionality of the basic quantities:

$$[N_1] = [\Delta P]^x [t]^y [l]^z [T_K]^q \quad (5)$$

On the basis of Π -theory we find 14 dimensionless groups (Π -terms) from the considered dimensional quantities.

$$\Pi_{d_p} = \frac{1}{d_p}; \quad \Pi_g = \frac{1}{g t^2}; \quad \Pi_v = \frac{t v}{1}; \quad \Pi_v = \frac{1^2}{t \cdot v} = \frac{v \cdot 1}{v}; \quad \Pi_g = \frac{\Delta P}{\rho}$$

$$\Pi_\rho = \frac{\Delta P}{\rho v^2}; \quad \Pi_\phi = \phi; \quad \Pi_\alpha = \alpha; \quad \Pi_R = \frac{1}{R T_K}; \quad \Pi_{\sigma_1} = \frac{\Delta P}{G_1}; \quad \Pi_{n_1} = n_1;$$

$$\Pi_{\rho_{gr}} = \frac{\Delta P}{\rho_{gr} \cdot v^2}; \quad \Pi_{m_t} = \frac{\Delta P \cdot t \cdot 1}{m_t}; \quad \Pi_\delta = \delta \quad (6)$$

If we take P , g and l as fundamental quantities, we obtain two more dimensionless numbers containing ρ , namely:

$$\frac{\Delta P}{\rho_{gr} \cdot g \cdot l} \text{ and } \frac{\Delta P}{\rho_1 \cdot g \cdot l} \quad (7)$$

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Based on the above considerations it is established that when the process of gas-jet canal cleaning is modelled, the set of dimensionless numbers (6) and (7) must be observed.

However, complete similarity (according to all the dimensionless numbers) can not always be realized in modelling (3). Therefore we will conduct a similarity analysis with the goal of eliminating from set (6) and (7) criteria characterizing the effect of unimportant factors.

Similarity of the full scale and model processes is established by observing the given criteria. This can be done by two methods. With the first method parameters for the surrounding environment and gas pressure can be changed in the model, leaving the gas, ground and lining material densities unchanged. Then, in order to realize similarity the gas pressure ΔP and the ground and lining durability characteristics (σ and σ_1) must be changed proportionally to a linear scale. In the second method the durability characteristics of the surroundings and the gas pressure are left unchanged. To observe the criteria of similarity it is then necessary to change the ground and lining densities or the acceleration of free fall, which requires use of the method of centrifugal alteration of the gravitational force.

The dimensionless number $\frac{\Delta P}{\rho_1 g l}$ is most important for studying the moment when a particle or aggregate breaks away from the main mass in the case of cohesive soils. For loose or waterlogged soil ($c \rightarrow 0$) and when studying the movement of a particle or aggregate, modelling cannot be accomplished with this criterion.

The dimensionless number $\frac{1}{d_{inc}}$ necessitates a corresponding reduction of the soil particle dimensions. However, this is practical only for monogeneous soils and only to certain size limits. In the other cases it is necessary to use real soil for the model. When large inclusions are present it is necessary to reduce the size of the latter in conformance with the criterion $\frac{1}{d_{inc}}$.

The criterion $\frac{\Delta P}{\rho_1 g l}$ cannot be observed, since destruction of the lining is not allowed in nature and, on the contrary, the constancy of its static state is absolute. For this it is important that the ratio $\frac{\Delta P}{\sigma_1}$ is the same in the model as in nature. In this case violation of similarity with respect to the porosity of the lining is permissible.

Thus, for approximate modelling of the gas-jet canal cleaning process it is possible to eliminate the criteria n_1 and $\frac{\Delta P}{\rho_1 g l}$ from the set (6) and (7), and the criterion $\frac{1}{d_p}$ holds partially only in respect to inclusions.

In the gas-jet cleaning of canals the removal of detritus is caused either only by the gas flow or by the flow in combination with mechanical action on the ground (1). All criteria which pertain to a mechanical action on

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the ground were presented in the set of dimensionless numbers (6) and (7). Consequently, set (6) and (7) can be used for modelling the cleaning process for any technological scheme. It is only necessary to consider that the effect of specific dimensionless numbers will be different for different ground conditions. The linear scale for the model of gas-jet cleaning has some limitations: in the permissible error of measurement, the gas flow regime and the possible volume of ground interacting in the model.

Formulas for determining the coefficient of reduction of linear dimensions (k_1) according to

The linear reduction coefficient for an operative gas-jet cleaning system can be determined by the dimensions of the funnel formed from the interaction of the gas-jet with the ground:

$$W_m = \pi r_n^2 h_n K_1^{-3} \quad (8)$$

where W_m is the volume of ground interacting in the model, r_n is the actual radius of the jet and h_n is the height of the detritus layer.

Then

$$K_1 \leq \left(\frac{\pi r_n^2 h_n}{200 d_p^3} \right)^{1/3} \quad \text{or} \quad K_1 \leq \frac{1}{4 d_p} \left(r_n^2 h_n \right)^{1/3} \quad (9)$$

Thus, in this study we obtained the set of dimensionless numbers (6) and (7) for modelling the process of gas-jet canal cleaning; this set of criteria considers more factors than those used in other fields (hydrodynamics and gas dynamics, airport operation, in modelling the operation of road construction machines). We also obtained equation (9) for determining a linear scale for the possible volume of ground interacting in the model of gas-jet cleaning.

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AGROTECHNOLOGY

MICROFLORA OF AIR IN VETDISPENSARIES AND THE MORBIDITY OF CALVES

Moscow KOKLADY VSESOYUZNOY ordena LENINA AKADEMII SEL'SKOKHOZYAYSTVENNYKH
NAUK imeni V.I. LENINA in Russian No 10, 1978 pp 32-34

Article by Candidate of Veterinary Sciences A. P. Gorbunov, Vologodskiy
Scientific Research Veterinary Station

Text The construction of large livestock rearing complexes and specialized farms for livestock production on an industrial basis introduces many new and urgent problems in the protection of animal health and the prosperity of husbandry from diseases. Crowding of livestock creates more favorable conditions for the transmission and distribution of infectious diseases by contactile and noncontactile means. The risk of micorbism, i.e. seeding of the animals' environment with microbes, is increased.

In large industrial complexes along with disease caused by obligate pathogenic microorganisms the possibility of diseases caused by conditionally pathogenic microbes increases.

Favorable situations for the reproduction of conditionally pathogenic microbes, as a rule, result from a reduction of the animal's natural resistance and a disturbance of the equilibrium of its microbial associations in evolutionarily formed ecological systems. Moreover, as a result of the passage of large numbers through the bodies of weakened, susceptible animals and reproduction, the virulence of conditionally pathogenic microflora can increase significantly, and mass sickness appears as a result of this.

Over 2 years we studied the microbial contamination of air in vetdispensaries and its relation to the morbidity of newborn calves.

The work was conducted in vetdispensaries of the 800 cow dairy complex of the "Peredoviy" sovkhov in Vologodskaya Oblast. The complex has 4 cattle yards for 200 cows each, 2 calf pens for group nursing of 446 calves from 20 days to 6-8 months and 2 maternity sections with vetdispensaries, each holding 21 calves, for animals up to 20 days of age.

The feeding of pregnant cows and cows which have calved and the nursing conditions for newborn calves at the complex satisfy veterinary-zootechnic requirements. During the period of study the temperature and relative humidity were close to the optimal levels.

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Bacterial contamination of the air was determined by the method of sedimentation on Petri dishes with beef-extract agar and Endo's medium. Tests were conducted twice per month. A clinical examination was given and blood was taken at the same time for immunological, biochemical and morphological studies.

The studies showed that the number of microbes in the air of the facilities varied over months.

The highest indices of general microbe contamination--up to 26.2 thousand/m³--were noted in the winter-spring period, and the number of *Escherichia coli* was greater in spring and the beginning of summer--1.1-1.2 thousand/m³. In addition it is important to note that within one month the total number of microbes in the air at one vetdispensary was 4-7 times greater than at another in individual cases.

The microbial contamination of air depends on many factors, and it is primarily affected by the frequency and quality of disinfection.

Thus, when disinfection was conducted each month the total number of microbes was on the average 11.6 ± 2.5 thousand/m³ and the number of *E. coli* was 0.3 ± 0.1 thousand/m³. These numbers are 2.5 times and 8 times greater, respectively, than when disinfection was conducted every 3 months.

A second factor affecting the microbe content of the air is the number of animals in the facility.

From the data presented in table 1 it is apparent that the microbial contamination of air in a vetdispensary increases with the number of calves in the facility.

When the strength of the effect of both factors on the total microbial contamination of the air at the facilities was determined the total effect of them-- $\chi^2=0.584$ ($P<0.01$)--and the effect of the first fact-- $\chi^2_A=0.481$ ($P<0.01$)--were shown to be significant.

A significant effect on the leve of *E. coli* is shown by the first factor-- $\chi^2_A=0.414$ ($P<0.001$)-- , the combined factors-- $\chi^2_{AB}=0.207$ ($P<0.01$)-- and their total action-- $\chi^2_x=0.669$ ($P<0.001$).

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Table 1. The microbial contamination of air in a vetdispensary in relation to the number of calves contained in it (thousand/m³)

(1) Показатель	(2) Количество телат в помещении			
	(3) нет	(4) до 10	11-21	более 21 (5)
(6) Общее количество микробов	4.4 ± 0.8	14.8 ± 2.4	17.3 ± 0.9	26.0 ± 1.0
(7) Количество кишечной палочки	0.1 ± 0.03	0.3 ± 0.07	1.7 ± 0.14	2.4 ± 0.13

Key:

- | | |
|-------------------------------------|-----------------------------|
| 1. Index | 4. Up to 10 |
| 2. Number of calves in the facility | 5. Over 21 |
| 3. None | 6. Total number of microbes |
| | 7. Number of E. coli |

Parallel with the effect of these factors in increasing the total number of microbes and the number of E coli in the air, it was noted that the virulence of conditionally virulent microflora (primarily of E. coli) changes with the length of time that the facilities are not subjected to disinfection, particularly when the animals are crowded. This can lead to massive sickness of newborn calves with colibacillosis, which we observed in one of the vetdispensaries (table 2.)

Table 2. The effect of the frequency of disinfection and the number of calves on the virulence of E. coli isolated from air at the facilities

(1) Сроки проведения дезинфекции	(2) Содержалось телат		(3) Выделено кишечных палочек				
			(7) в том числе				
	всего (4)	в т. ч. больных (5)	всего (6)	авирулентных (8)	слабовирулентных (9)	вирулентных (10)	высоковирулентных (11)
Через (мес) (12) { 1 3 5	21 108 213	3 36 103	5 10 15	5 4 4	- 1 5	- 5 3	- - 3

Key:

- | | |
|---|---------------------|
| 1. Frequency of disinfection | 6. Of those |
| 2. Number of calves | 7. Of those |
| 3. Number from which E. coli was isolated | 8. Nonvirulent |
| 4. Total | 9. Weakly virulent |
| 5. Number of those sick | 10. Virulent |
| | 11. Highly virulent |
| | 12. After (months) |

It should be noted that when the facilities are not disinfected for a time, virulent E. coli cultures are at first isolated only from the calf feces, and only after a month are they isolated from the air.

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The microbial factor has an effect on newborn calves. When the number of microbes in the air at the facilities increases, the amount of gamma-globulin in the animals' blood serum and its antibacterial activity are reduced, and leukocyte phagocytotic activity is increased. There is a direct relation between the microbial contamination of air at the facilities and the morbidity of newborn calves.

The coefficients of correlation between the total microbial contamination of the air and the number of E. coli in it and calf morbidity were 0.605 and 0.614 respectively ($P < 0.01$).

Using dispersion analysis it was determined that the strength of the effect of both factors combined was $r = 0.542$ ($P < 0.01$) while the strength of the effect of E. coli was $r = 0.457$ ($P < 0.01$). The effect of E. coli on calf morbidity appeared more strongly when there was a low level of gamma-globulin in their serum ($r = 0.467$, $P < 0.001$).

Taking into account the effect of the microbial factor on the morbidity of newborn calves, we tested a number of measures directed towards reducing the microbial contamination of air at the facilities. In particular, the microbial contamination of air and calf morbidity were determined at facilities operated according to the principle "fully occupied--fully vacant". The obtained data was compared with data obtained at facilities in which the animals were not evacuated for a long time (2 months and more) and the pens were disinfected only when evacuated. These facilities served as controls.

In facilities operated according to the "fully occupied--fully vacant" principle it was shown that the total number of microbes was 2 times lower and the number of E. coli was 4 times lower than in the air at control facilities. In these facilities on the average 11.0 and 48.6 percent of the calves had these microbes, respectively, and this was 4 times less than in the control.

It was determined that if a vetdispensary is cleaned after 5 days, then about 3 percent of the calves become sick. If this time is lengthened to 10 days or more, the morbidity increases to 20 percent and higher.

Thus, the studies we conducted showed that microbial contamination of the air affects the health of calves. The total number of microbes in the air and especially the E. coli content must be considered when evaluating the sanitation of vetdispensaries.

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CRYOBIOLOGY

UDC 577.1

EFFECT OF SUPERLOW TEMPERATURES ON TRANSLATION ACTIVITY OF CELL-FREE EXTRACTS OF DIFFERENT ORIGIN

Moscow IZVESTIYA AKADEMII NAUK SSSR-SERIYA BIOLOGICHESKAYA in Russian No 3, 1979 received by editors 19 Sep 77 pp 442-445

Article by Gulevskiy, A. K., Institute of Problems of Cryobiology and Cryo-medicine of the Ukrainian SSR Academy of Sciences, Khar'kov/

Text The effect of various freezing (-196°C)-thawing regimes on the protein synthesizing activity of cell-free extracts from Krebs II ascites carcinoma, rat liver and wheat was studied. It was established that the biosynthesis of protein stimulated by exogenous matrices was reduced under slow freezing-thawing regimes of cell-free extracts from Krebs II ascites carcinoma. Similar results were obtained during an investigation of the endogenous protein synthesizing activity of the cell-free extract from rat liver and Krebs II ascites carcinoma. A significant decrease in the translation activity of the cell-free extract from wheat germs under the studied freezing-thawing regimes was not observed. It was shown that the cell-free extract from Krebs II ascites carcinoma had the greatest sensitivity to the effect of low temperatures.

Studies by A. M. Belous and coauthors (1975), as well as by Henderson and Angeloff (Henderson, Angeloff, 1969) showed that a decrease in the level of protein biosynthesis was observed in cells and tissues subjected to the effect of superlow temperatures. According to the available data, it is assumed that a disruption in the intactness of the plasma membrane, lysosomes and cell nucleus played an important role in this (Belous et al., 1975). It is not ruled out, however, that a direct injury to components taking part in translation, that is, enzymes and protein synthesis factors, ribosomes and RNA, is of great importance (Spirin and GavriloVA, 1971). In particular, Heywood (Heywood, 1970) reports on the sensitivity of factors of initiation from the muscles of chick embryos to the effect of low temperatures. Takanami (Takanami, 1960) points to the loss of activity of ribosomes from rat

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liver under conditions of storage at -40° . Thus, it is possible that injury to one or several components participating in translation brings about the observed decrease in protein biosynthesis in the conserved bioobjects.

This work studied the effect of various freezing-thawing regimes on the capacity of the postmitochondrial supernatant from Krebs II ascites carcinoma and from wheat germs for translation of RNA from the encephalomyocarditis virus and polioA containing iRNA from Krebs II ascites carcinoma, as well as on the endogenous protein synthesizing activity of postmitochondrial supernatants from rat liver and from Krebs II ascites carcinoma.

Materials and Methods

The derivation of cell-free extracts from the sources indicated above (S_{30}) was described in the work by T. Yu. Ugarova and coauthors (1973), Marcus (Marcus et al., 1968) and A. K. Gulevskiy (1976).

Quick freezing of cell-free extracts to -196° was done at a speed of 200 to 400° per min and slow freezing, at a speed of 0.5 to 2° per min. Quick thawing was done in a water bath at 37° and slow thawing, at 2 to 4° .

The cell-free system from wheat germs contained the following components (in mM): ATP-1, GTP-0.05, KP (creatine phosphate)-10, KP-kinase-40 μ g/ml, mixture of nonlabeled amino acids without lysine-0.03 each, DTT (dithiothreitol)-2, GEPES-20 (all the above-enumerated reagents are of the Calbiochem Firm), K-acetate of extreme purity-90, Mg-acetate of extreme purity-3.5 and C^{14} -lysine (of the Amersham Firm)-0.2 μ Ci/sample. The following was added to every sample of a total volume of 50 μ l: 2 μ g of ascites polioA containing iRNA and 30 to 40 optical units of the postmitochondrial supernatant passed through a Sephadex G-25 column equilibrated with buffer containing (in mM) GEPES, pH=7.7-20, K-acetate-120 and Mg-acetate-5.

The cell-free system from Krebs II ascites carcinoma contained the following components (in mM): ATP-1, GTP-0.1, KP-10, KP-kinase-16 μ g/ml, Tris-HCl, pH 7.5-30, KCl of extreme purity-85, $MgCl_2$ of extreme purity-3.5, mixture of nonlabeled L-amino acids without lysine-0.03 and C^{14} -lysine-0.2 μ Ci/sample. The following was added to every sample of a total volume of 50 μ l: 30 to 40 optical units of the postmitochondrial supernatant passed through a Sephadex G-25 column equilibrated with buffer containing (in mM) Tris-HCl, pH 7.5-30, KCl-85 and $MgCl_2$ -3.5

During the study of translation in the Krebs II cell-free system stimulated by encephalomyocarditis virus RNA preincubation of the cell-free extract, as described in the work by T. Yu. Ugarova and coauthors (1973), was carried out and 1.6 μ g of virus RNA were added to each sample.

PolioA containing iRNA from Krebs II ascites carcinoma cells and RNA from the encephalomyocarditis virus obtained by the methods described in the work by Marcus (Marcus et al., 1968) and Aviv (Aviv et al., 1971) respectively were kindly made available by T. Yu. Ugarova, worker at the laboratory of bioorganic chemistry at Moscow State University.

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Incubation of the cell-free system from wheat germs was done at 30° and from Krebs II ascites carcinoma, at 37° during 1 hour. The composition of the cell-free system from rat liver and the conditions of incubation are described in the study by A. K. Gulevskiy (1976).

After the completion of incubation the reaction was stopped by placing the samples in an ice bath. Cold 10% TCA was added to the samples, which were heated for 20 min at 90°. Then the samples were cooled, applied to the RUF5 ultrafilters and washed with cold 5% TCA, 70% alcohol and chloroform three times. The filters were dried off and radioactivity was calculated in a standard toluene scintillator by means of the SL-40 Intertechnique scintillation counter (France). During the study of protein synthesis stimulated by exogenous matrices the radioactivity of residual synthesis on endogenous matrices and the radioactivity of a sample for nonspecific sorption, for which the radioactivity of a sample incubated at 2 to 4° was taken, was subtracted from the radioactivity of the samples. During the study of endogenous protein synthesis only nonspecific sorption was subtracted from the radioactivity of the samples.

The statistical processing of the data was carried out by the Fisher-Student method.

Results and Discussion

From data in the literature it is known that injuries to macromolecules during freezing-thawing are due mainly to the effect of such physicochemical factors as an increase in the concentration of electrolytes, change in the medium pH and so forth (Pushkar' and Belous, 1975). The effect of these factors is more pronounced at slow freezing-thawing speeds (Pushkar' and Belous, 1975). However, even after such an effect nucleic acids and many proteins retain their structural and functional state (Lystsov and coauthors, 1966; Pushkar' and Belous, 1975).

The data presented in figure 1, a, indicate that the cell-free extract from Krebs II ascites carcinoma subjected to quick freezing with subsequent quick or slow thawing translated encephalomyocarditis virus RNA at the level of control, whereas a significant inhibition of the translating activity of the cell-free extract is observed during slow freezing. These data agree well with the ideas presented above.

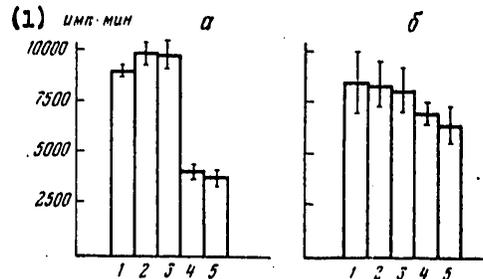
Another picture was observed during the freezing-thawing of the cell-free extract from wheat germs. In this case both under quick and slow freezing regimes a significant decrease in protein biosynthesis was not noted.

During the study of the effect of various freezing-thawing regimes on the endogenous protein synthesizing activity of the cell-free extract from rat liver (figure 2, a) it turned out that in this case slow freezing-thawing regimes and, especially, their combination led to a greater disturbance in the level of protein biosynthesis. However, it is interesting to note that

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under no freezing-thawing regime of the cell-free extract from rat liver did we observe such an inhibition in protein biosynthesis as was the case during the study of the effect of superlow temperatures on liver sections (Belous and coauthors, 1975) or homogenates (Gulevskiy, 1976). This attests to the role of secondary damaging factors, probably, occurring as a result of a simultaneous injury to such cell organoids as lysosomes, the nucleus and mitochondria. In particular, apparently, of great importance is the increase in nuclease activity in cells and tissues subjected to freezing-thawing as a result of an injury to lysosomes (Persidsky and Ellett, 1971). As a consequence, the degradation of polynucleotides in tissues subjected to freezing-thawing accelerates greatly (Higashi and Buch, 1965). An investigation of the effect of various freezing-thawing regimes on the endogenous protein synthesizing activity of the cell-free extract from Krebs II ascites carcinoma made it possible to establish that both quick and slow freezing regimes had a significant inhibiting effect (figure 2, b). As before, more significant changes took place during the combination of slow freezing with slow thawing. It should be noted that the inhibition of protein biosynthesis in the cell-free extract from Krebs II ascites carcinoma is more pronounced as compared with the cell-free extract from rat liver.



Key:

1. Counts per minute

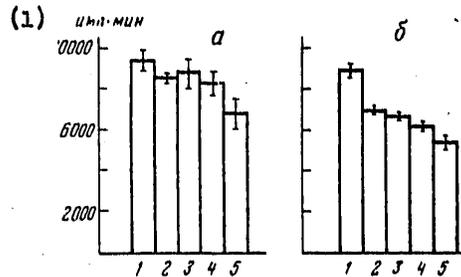
Fig. 1. The effect of various freezing-cooling regimes on protein biosynthesis in cell-free extracts from Krebs II ascites carcinoma and wheat germs stimulated by exogenous matrices: a--translation of encephalomyocarditis virus RNA in the cell-free system from Krebs II ascites carcinoma; 6--translation of polIA mRNA from Krebs II ascites carcinoma in the cell-free system from wheat germs; 1--control, 2--quick freezing-thawing at 37°C; 3--quick freezing-thawing at 2 to 4°C; 4--slow freezing-thawing at 37°C; 5--slow freezing-thawing at 2 to 4°C.

An analysis of the data obtained makes it possible to conclude that among the investigated cell-free extracts the cell-free extract from Krebs II ascites carcinoma is the most sensitive to the effect of low temperatures.

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Key:

1. Counts per minute

Fig. 2. The effect of various freezing-thawing regimes on endogenous protein biosynthesis in cell-free extracts from rat liver and Krebs II ascites carcinoma: a--protein biosynthesis in the cell-free system from rat liver; b--protein biosynthesis in the cell-free system from Krebs II ascites carcinoma; 1--control, 2--quick freezing-thawing at 37°C; 3--quick freezing-thawing at 2 to 4°C; 4--slow freezing-thawing at 37°C; 5--slow freezing-thawing at 2 to 4°C.

Thus, the cell-free systems of protein synthesis of different origin contain components sensitive to the effect of superlow temperatures. The inhibition of protein biosynthesis observed in this case depends on the source of origin of the cell-free system and is more pronounced under slow freezing-thawing regimes.

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ECOLOGY

UDC 632.9

EVALUATION OF THE GENETIC DANGER OF PESTICIDES

Moscow IZVESTIYA AKADEMII NAUK SSSR-SERIYA BIOLOGICHESKAYA in Russian No 3, 1979 received by editors 28 Mar 77 pp 401-409

Article* by Kas'yanenko, A. G., and Koroleva, N. S., Department of General Genetics of Cotton of the Tadzhik SSR Academy of Sciences, Dushanbe/

Text Literature and the author's data on the genetic effect of 160 pesticides are presented. The methods and test-objects used for the detection of genetically active pesticides are analyzed. A diagram for screening pesticides with a mutagenic effect at all the levels of organization of living things is proposed.

In connection with the profound effect of pesticides on the biosphere the need for a detailed study of the genetic effects of pesticides on the series of test-systems is stressed.

The threat of epiphytotics and mass reproduction of pests and causative agents of animal diseases is the constantly acting background of modern agriculture. In a number of cases the protection of biological productivity through the development of resistant varieties does not withstand the pressure of parasites and causative agents of diseases. All this makes it necessary to develop a complex system for the chemical protection of the harvest, which by now has been transformed into a new, previously unknown, ecological factor.

An analysis of the prospects for the development of agricultural production and forestry shows that, even if the "chemical pressure" on the environment is slightly reduced in the nearest future, this will not be sufficient to remove it as an ecological factor. Under these conditions knowledge of the physiological and genetic consequences of the use of chemical agents for the cultivation and protection of the harvest becomes absolutely necessary.

*From the report read at the All-Union Workers' Conference "Ecological Consequences of a Systematic Application of Pesticides and Other Agents for the Control of Harmful Organisms in Ground and Fresh Water Ecosystems" (Pushchino, 29 November-21 December 1976).

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Among the various categories of chemical compounds used in modern agriculture and forestry, apparently, pesticides have the most negative accompanying effect. Significant factual data showing that many pesticides act directly on hereditary structures, causing their permanent changes, mutations, have now been accumulated. As yet, however, there is no general picture of the effect of pesticides on the mutational variability of individual organisms. The study of the genetic effects of pesticides is now going through an "empirical" stage. This is due to a number of factors; first, to the abundance and diversity of the pesticides themselves. The world assortment of pesticide preparations now has more than 100,000 items based on more than 900 chemical substances belonging to various categories, mainly, of organic compounds. Second, the study of genetic effects of pesticides is hampered by the vast number and diversity of organisms on which they have an effect, in a number of cases by the lack of data on the level of spontaneous mutational variability under natural conditions, which should be the basis for an evaluation of the level of induced variability, by the lack of biosphere reservations in the zone of intensive farming and by the wide use of pesticides. Third, the above is due to the small number of biological tests for an evaluation of the prolonged effect of the low concentrations of these substances and to the lack of methods of a quantitative evaluation of the mutational effect of pesticides.

A preliminary systematization of the evaluation of the genetic effects of pesticides showed that approximately 86 out of the 160 studied compounds produced a mutagenic effect at least on one of the studied organisms (Kurinyy and Pilinskaya, 1974; Siebert and Lemerle, 1974; Bridges, 1975; Giskin, 1976; Istamov, 1976).

Table 1 summarizes the data of more than 100 authors working with various objects. Systematic studies of the mutagenic properties of pesticides in one specific test-object have appeared recently. For example, authors (Nady et al., 1975; Shirasu et al., 1976) studied the mutagenic effect of more than 180 pesticides on the bacteria *Escherichia coli* in the capacity for producing reversions to prototrophicity from auxotrophy due to tryptophan. Of the investigated compounds only 12 substances possessed a clearly pronounced mutagenic activity.

In our laboratory on the microscopic fungus *Verticillium dahliae* the following 13 pesticides received an evaluation of the biological effect: fundazol, thiophanatemethyl, DNC, demosan, fentiuram, sevin, phasalone, HCCH, dalaon, pachtaran, ziram, magnesium chlorate and TCA. It was established that sevin, demosan and ziram possess a mutagenic activity. The mutagenic effect was evaluated according to the appearance of mutants with a change in morphological signs. The fungicide benleyt possesses a weak mutagenic effect, but is a rigid selective factor. About 70 mutants resistant to it were obtained. Some of them are highly aggressive to the cultivated cotton varieties. Some pesticides stimulated the germination of spores of the causative agent of wilt and increased its aggressiveness (Kas'yanenko et al., 1977). In practice, all the pesticides studied by us possessed a certain degree of biological activity with respect to the microscopic fungus of the causative agent of wilt.

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Table 1. Mutagenic Effect of Pesticides

Класс пестицидов (1)	Отношение числа исследованных пестицидов к числу пестицидов, давших мутагенный эффект (2)					Потенциально мутагены по числу пестицидов, % (3)
	микроорганизмы (4)	растения (5)	насекомые (6)	млекопитающие (7)	всего (8)	
Фунгициды (9)	$\frac{17}{8}$	$\frac{11}{10}$	$\frac{6}{3}$	$\frac{10}{6}$	$\frac{44}{25}$	57
Инсектициды (10)	$\frac{16}{5}$	$\frac{23}{20}$	$\frac{8}{5}$	$\frac{23}{14}$	$\frac{70}{44}$	63
Гербициды (11)	$\frac{43}{4}$	$\frac{25}{24}$	$\frac{12}{9}$	$\frac{17}{4}$	$\frac{97}{41}$	42
Прочие (12)	$\frac{1}{1}$	$\frac{10}{10}$	—	$\frac{8}{4}$	$\frac{19}{15}$	88
Всего (8)	$\frac{77}{18}$	$\frac{69}{64}$	$\frac{26}{17}$	$\frac{58}{28}$	$\frac{230}{125}$	54
(13) Мутагены, обнаруженные на данном тест-объекте, %	23	93	65	48	54	

Key:

- | | |
|--|---|
| 1. Category of pesticides | 6. Insects |
| 2. Ratio of the number of investigated pesticides to the number of pesticides that produced a mutagenic effect | 7. Mammals |
| 3. Potential mutagens according to categories of pesticides, % | 8. Total |
| 4. Microorganisms | 9. Fungicides |
| 5. Plants | 10. Insecticides |
| | 11. Herbicides |
| | 12. Others |
| | 13. Mutagens detected in a given test-object, % |

An analysis of the level and volume of study of the mutagenic effect of pesticides shows the need for improving the methods of recording the genetic effects of these compounds. Since a significant number of new compounds is synthesized and introduced into production in the world every year, there is an acute need for developing and using rapid and effective methods of recording the mutagenic danger of new pesticides and those already in use. Determination of the mutagenic effect of a newly synthesized substance on the basis of the chemical structure would be an ideal case of the evaluation of this property. However, the existing experience shows that it is difficult to forecast the mutagenic effect or its absence according to the chemical structure. Forecasting based on the chemical structure is tentative (table 2).

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Table 2. Distribution of Potential Mutagens According to Chemical Categories of Pesticides

(1) Химический класс пестицидов	Отношение числа исследованных пестицидов к числу пестицидов, давших положительный эффект (2)	Вверху--использованные тест-объекты, внизу--тест-объекты, из которых получен положительный эффект (3)
Углеводороды и их производные (4)	$\frac{14}{14}$	$\frac{1\ 2\ 3\ 4^*}{1\ 3\ 4}$
Нитросоединения (5)	$\frac{2}{1}$	$\frac{1\ 4}{4}$
Спирты, простые эфиры, фенолы, хиноны (6)	$\frac{13}{11}$	$\frac{1\ 2\ 3\ 4}{1\ 2\ 3}$
Амины (7)	$\frac{4}{1}$	$\frac{1\ 2}{1\ 2}$
Производные карбоновых кислот (8)	$\frac{16}{9}$	$\frac{1\ 2\ 3\ 4}{1\ 2\ 3\ 4}$
Производные арилоксалкилкарбоновых кислот (9)	$\frac{13}{5}$	$\frac{1\ 2\ 3\ 4}{1\ 2\ 3\ 4}$
Производные карбаминной, тино- и дитиокарбаминной кислот (10)	$\frac{22}{15}$	$\frac{1\ 2\ 3\ 4}{1\ 2\ 3\ 4}$
Производные мочевины и тиомочевины (11)	$\frac{8}{2}$	$\frac{1\ 2\ 3}{1\ 2\ 3}$
Меркаптаны, сульфиды и их производные (12)	$\frac{5}{3}$	$\frac{1\ 2\ 4}{1\ 2\ 4}$
Сульфокислоты и их производные (13)	$\frac{3}{0}$	$\frac{1\ 2}{-}$
Органические соединения ртути (14)	$\frac{2}{2}$	$\frac{2\ 4}{2\ 4}$
Органические соединения фосфора (15)	$\frac{26}{15}$	$\frac{1\ 2\ 3\ 4}{1\ 2\ 3\ 4}$
Гетероциклические соединения (16)	$\frac{27}{12}$	$\frac{1\ 2\ 3\ 4}{1\ 2\ 3\ 4}$
Неорганические пестициды (17)	$\frac{2}{2}$	$\frac{2\ 4}{2\ 4}$
Всего (18)	$\frac{161}{86}$	

*1--microorganisms, 2--plants, 3--insects, 4--mammals.

Key:

- | | |
|---|--|
| 1. Chemical category of pesticides | 3. Above--used test-objects, below--test-objects at which a positive effect was obtained |
| 2. Ratio of the number of investigated pesticides to the number of pesticides that produced a positive effect | 4. Hydrocarbons and their derivatives |
| | 5. Nitrocompounds |

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|--|--|
| 6. Alcohols, ethers, phenols and quinones | 12. Mercaptans, sulfides and their derivatives |
| 7. Amines | 13. Sulfonic acids and their derivatives |
| 8. Derivatives of carboxylic acids | 14. Organic mercury compounds |
| 9. Derivatives of arylhydroxy-alkylcarboxylic acids | 15. Organic phosphorus compounds |
| 10. Derivatives of carbamic and thio- and dithiocarbamic acids | 16. Heterocyclic compounds |
| 11. Derivatives of urea and thio-urea | 17. Inorganic pesticides |
| | 18. Total |

The problem of developing effective express-methods for an evaluation of mutagenic activity is common both for pesticides and for medicinal preparations, chemical industry waste, synthetic substances and chemical agents for everyday use. A study of the genetic nature of hereditary changes caused by "classical" mutagens, which gamma-rays and some chemical compounds (yperite, ethylmethanesulfonate, nitrosomethylurea and so forth) are, has shown that they can be very different.

Usually, any change, inherited in a number of generations, in morphological, physiological and biochemical characters determined by convariantly reduplicated cell structures is called mutation. The following types of mutations are distinguished: 1) point gene mutations invisible at the level of chromosomes, but clearly manifested phenotypically in the progeny; 2) various types of chromosome aberrations: deletions, duplications, inversions, bridges, splits and rings; 3) genome mutations: a multiple increase or decrease in the entire set of chromosomes and the appearance of haploids and polyploids; 4) mutations of cytoplasmatic structures--mitochondria, chloroplasts, ribosomes and the plasmon as a whole.

At present there is no universal method capable of recording all these types of mutations. Therefore, the problem of selecting objects and methods of evaluating the mutagenic activity of chemical compounds, in particular pesticides, is of great methodological importance.

Recording various types of chromosome aberrations in the somatic and sex cells of plants and animals and gene mutations in microorganisms are the methods used for the determination of the genetic effects of pesticides. By these methods it was possible to record the mutagenic effect in various objects for all categories of pesticides (Kurinnyy and Pilinskaya, 1974). Microorganisms (Siebert and Lemperle, 1974; Nady et al., 1975; Shirasu et al., 1976), higher plants (mitoses in the meristematic tissues of wheat, pea and tradescantia radicles (Shcherbakov et al., 1965; Prasad and Pramer, 1969; Kallak and Yarvekylg, 1971; Logvinenko, 1973) and laboratory animals, that is, mice and rats (Vogel et al., 1971; Matveyeva et al., 1973) are used as test-objects for an evaluation of the mutagenic activity of chemical compounds. A method of tissue cultivation and an analysis of chromosome aberrations in blood cells in man were used in a number of studies (Pilinskaya, 1974 a, b).

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The use of any one organism for an evaluation of mutagenic activity has a number of limitations. Despite the common molecular basis for heredity, differences in the permeability of cell membranes, detoxication, effectiveness of reparation systems and metabolism were established in microorganisms, higher plants and animals.

Often the products of a preparation's metabolism, not the preparation itself, have a mutagenic effect. Many compounds, not being mutagens for microorganisms in pure cultures, produced a mutagenic effect in the body of an animal. An "indirect" mutagenic effect was shown for a number of medicinal preparations: cycasin, isoniazid, cyclophosphamide and 1-(pyridyl-3)-3,3-dimethyltriazene (Fonshteyn et al., 1975).

In the last few years a number of studies have been devoted to the problem of selecting test-objects and genetic systems for an evaluation of the mutagenic effects of chemical pollutants of the environment (Nady et al., 1975; Shirasu et al., 1976; Fonshteyn et al., 1976).

A special Soviet-American symposium held in Dushanbe in April 1976--"Theoretical and Practical Approaches to the Problem of Mutagenesis and Carcinogenesis of the Environment"--was devoted to this problem. The development of test-systems for an evaluation of the mutagenic effect of chemical compounds should permeate the basic levels of organization of living things: molecular, cellular, organism and population. A study of the effect of the assumed mutagenic factors at the level of their interaction with DNA is now being conducted (Lekyavichyus, 1976). A study of the effect of mutagens at this level makes it possible to disclose the primary chemical mechanisms of the mutational process and carcinogenesis. Recording DNA splits can be a possible express-method in the screening of mutagens. Of great importance is the study of the interaction of chemical compounds with individual enzyme systems, that is, specific inhibitors and activators.

However, the genetic effect of a pesticide is realized at the cellular level, where reparation systems function. It is well known that the effectiveness of the effect of reparation systems is very high. For example, a cell of saccharomyces fungi normally tolerates up to 3,000 dimers, whereas in mutant lines with a disturbance in reparation systems the occurrence of several dimers already leads to a lethal outcome. In connection with this mutants of various microorganisms and tissue culture of higher organisms with a disturbance in reparation systems can be good test-systems for the study of the mutagenic effects of chemical compounds. Such mutants were described for yeast (Zakharov, 1976) and human cells (Pashin and Kazachenko, 1976). Mutants with a block in the reparation system, on the one hand, can be indicators for very small concentrations of mutagens and weak mutagens and, on the other, can reveal the role of reparation systems for various types of injuries to hereditary structures. Both direct and reverse mutations can be used as genetic systems for an evaluation of mutagenic effects. A large number of studies were conducted with E. coli, during which reverse mutations from auxotrophy to prototrophicity were used (Nady et al., 1975; Shirasu et al., 1976). To record the occurrence of direct mutations, it is best to take mutations of

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resistance to certain substances. In this case an analysis of a large number of cells and a strict quantitative recording of various mutational events are possible. As a model for recording the mutagenic effects of pesticides we use both the morphological mutants of the microscopic fungus *V. dahliae* and the mutations of resistance to benleyt.

The importance of the mutagenic effect of chemical compounds at the molecular and cellular level is very important, but not all the substances that produce a mutagenic effect on microorganisms always induce mutations in multicellular higher organisms. As already indicated earlier, a number of chemical substances, including pesticides, affect the hereditary structures of the cell not "in pure form," but with the products of metabolism. Cases when the products of metabolism were more active mutagenic factors than the initial preparation were described (Fonshteyn et al., 1975).

The mutagenic activity of a preparation should be evaluated on multicellular organisms. At present lines of mice and rats, as well as the thoroughly studied genetic object *Drosophila melanogaster*, are mostly used for these purposes. Recently, attempts have been made to evaluate the mutagenic effect of various chemical compounds directly on man, using methods of recording chromosome aberrations in blood cells, as well as the characteristics of the structure of hemoglobin and other proteins (Wolf et al., 1975). This makes it possible to "unify" in one object all the levels of organization and study of living things. Differentiation of the reaction of various population genotypes to the effect of pesticides has now been shown clearly. The role of the genotype in sensitivity or resistance is very great and affects not only various biotypes within the population, but also species of different sexes within one biotype.

The gonadotropic effect was determined for a number of pesticides. For example, it was established that the products of DDT transformation in birds accumulate mainly in gonads. In the blackheaded gull the concentration of DDT products in ovaries reached 10 mg/kg, which exceeded their concentration in fat 2.8 times and in the liver and muscles 6.6 times. The concentration of the products of DDT transformation in testes reached 15 mg/kg, which exceeded the concentration in fat 4.4 times and in the liver and muscles 10 times. Evidently, the high concentration of the products of DDT transformation in gonads can lead to the occurrence of mutations in the formed cells, which is recorded in the study of the progeny. The mutagenicity of DDT metabolites was shown on the pomace fly. In the study of the common grebe, which is fed exclusively with fish, the number of DDT metabolites in the eggs averaged 1.38 mg/kg. Out of 272 eggs 31.2 percent did not hatch and in the insect-eating type (the blackheaded gull, where the concentration of mutagens was 0.87 mg/kg, on the average) out of 760 eggs 9.21 percent did not hatch and 3.28 percent of the chicks died at an early age. It is assumed that the nonhatching of chicks is the consequence of DDT-induced dominant lethal genes. The data on the accumulation of chlororganic compounds in the gonads and gametes of animals can also serve as an indirect evaluation of their genetic danger for man (Lekyavichyus et al., 1976).

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Since pesticides are used not against an individual species, but against populations in biogeocenoses and agrocenoses, it is very important to have means of evaluating the genetic effects of pesticides at the population level. In the last few years methods of population genetics have been used more and more extensively for an evaluation of the effect of unfavorable environmental factors, including pesticides, on the genofond of a species, but a universal, inexpensive and economic method has not yet been found, with the exception, perhaps, of the pomace fly test (Shvartsman, 1976).

The plant *Arabidopsis thaliana* from the mustard family can be a good model object for an evaluation of the genetic effects of pesticides on higher plants. This is a plant with a very short vegetative period. There are lines with a cycle of development from seed to seed of 28 to 30 days. It can be grown under strictly controlled conditions of asepsis in test tube and dish cultures. The mutational spectrum under the effect of "classical mutagens" was well studied in it. Linkage groups were detected. Auxotrophic mutations were obtained. A tissue culture was developed, as a result of which methods of microbiological analysis are applicable to this object. Most importantly, in it it is possible to record the mutational effect on plants of the M_1 -generation and, similarly to rats and mice, a method of recording embryonal lethal genes has been developed (Usmanov and Myuller, 1970). The existence of this method makes it possible to use *Ar. thaliana* for a study of the mutagenic effect at a minimum of three levels of the organization of living things: cellular, organism and population.

An analysis of the existing methods of evaluating the mutagenic effect of chemical compounds shows that, despite certain difficulties, the combination of the methods enumerated above makes it possible to reliably evaluate the presence or lack of the mutagenic effect of current pesticides.

The conditions of evaluation of the mutagenic effects of chemical compounds are generally acknowledged: 1) use of several objects, that is, microorganisms, plants and laboratory animals; 2) stages in the evaluation of the mutagenic effect.

At first work is done on simpler and cheaper systems of microorganisms. Then, in case there is no mutagenic effect on microorganisms, the test is conducted on laboratory animals, model objects of plants and model populations. Overall, this can be expressed in the form of the following diagram (diagram).

A strict evaluation of the potential genetic effects of newly synthesized compounds would prevent a wide distribution of substances possessing a genetic effect. Preparation of a register of mutagens among the used pesticides would contribute to their replacement with genetically less active.

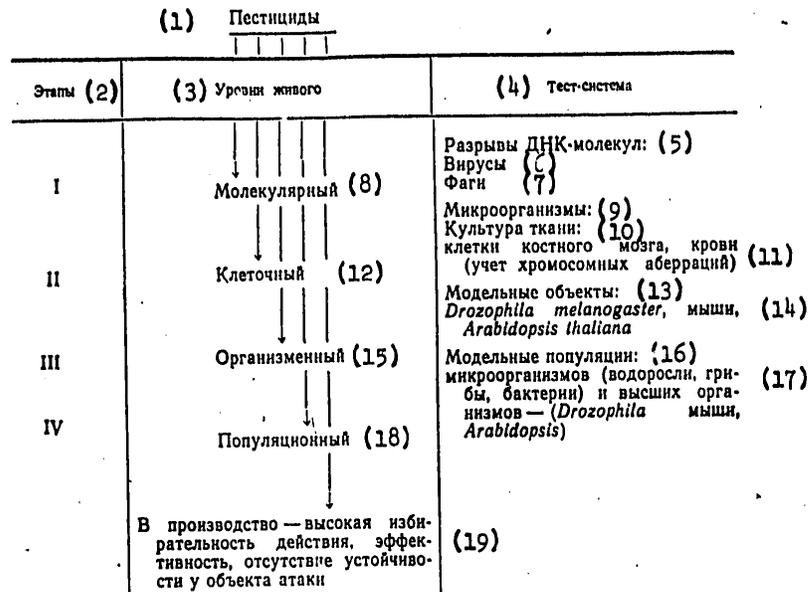
The problem of the threshold of effect of a mutagen is of great methodological importance for an evaluation of the genetic danger of pesticides. In the literature there are two points of view as to the existence of safe pesticide concentrations. Some authors believe that for genetically active chemical substances, including pesticides, it is possible to introduce maximum permissible concentrations on the basis of the fact that some molecules can be

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sorbed by cell membranes and inactivated by reparation systems. The conclusion on the existence of a threshold of mutagenic activity is drawn on the basis of this (Dubinin, 1976). Maximum permissible doses for the components of the environment and objects of the work zone are developed on the basis of this.

Diagram

Methodology of Screening Genetically Active Pesticides



Key:

- | | |
|---|---|
| 1. Pesticides | 13. Model objects |
| 2. Stages | 14. <i>Drosophila melanogaster</i> , mice, <i>Arabidopsis thaliana</i> |
| 3. Levels of living things | 15. Organism |
| 4. Test-system | 16. Model populations |
| 5. DNA-molecule linkages | 17. Of microorganisms (algae, fungi, bacteria) and of higher organisms (<i>Drosophila</i> , mice, <i>Arabidopsis</i>) |
| 6. Viruses | 18. Population |
| 7. Phages | 19. In production--high selectivity of effect, effectiveness and lack of resistance in the object of attack |
| 8. Molecular | |
| 9. Microorganisms | |
| 10. Tissue culture | |
| 11. Marrow and blood cells (recording chromosome aberrations) | |
| 12. Cellular | |

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Other authors (Filippova and Izrael', 1976) believe that for chemical mutagens, as well as for a number of physical mutagens (gamma-rays, ultraviolet rays and so forth) there is no threshold of effect. The curves "dose-effect" and their extrapolation through the zero point attest to the single-stroke mechanism of mutational events. For the occurrence of mutation one act of interaction with the hereditary structures of the cell is sufficient. Recognition of this fact requires the prevention of environmental pollution even with small concentrations of mutagens, because the mutational pressure on the body is integrated by the entire combination of mutationally active substances. Therefore, during standardization it is necessary to proceed from the lack of threshold of the mutagenic effect of these substances. Low doses of chemical mutagens are dangerous, because they mainly induce point gene mutations and much less, more easily detected and eliminated chromosome aberrations. It is well known that gene mutations are more easily transmitted to the progeny and are accumulated as the genetic load of the population.

The capacity of chemical mutagens to produce sensibilization of the objects of attack is another important characteristic of these mutagens. For a number of chemical mutagens (ethylenimine), as well as pesticides (granosan, sevin, captan, morozine and so forth), the capacity with treatment with small doses to increase the sensitivity of cells to a subsequent sharp effect was determined. Thus, another ecologically dangerous property of pesticides is detected--repeated treatments more strongly affect the genofond of the population as compared with a single powerful effect (Vashakidze and Mandzhgaladze, 1976; Shvartsman, 1976).

The genetic effect of pesticides at the population level lies not only in an increase in the general level of mutational variability, but also in the vectorization of selection toward resistance. By now resistance has been detected in 250 species of pests and transmitters of diseases in man. Genetic resistance was described for nearly all the categories of modern pesticides. The problem of the acquisition of resistance to insecticides in insects was studied the most.

A number of pesticides, defoliants and physiologically active substances used on a large scale inhibit the rate of development and fertility in some species and stimulate physiological activity in other species and biotypes. In the final analysis, this disturbs the genetic equilibrium in populations and cenoses and can lead to a rapid degradation of a complex community. Some pesticides stimulate the development of phytopathogenic and pathogenic microorganisms and increase their aggressiveness (Gafurova, 1976).

Thus, an analysis of literary sources and our experimental data indicate that in a number of the world's regions pesticides have become a new ecological factor with a complex, versatile and profound effect on various organisms and their communities.

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The effect of pesticides in agro- and biocenoses can differ: 1) Some pesticides are mutagens increasing the general mutational variability within populations and changing the rate and nature of evolutionary processes; 2) pesticides can affect the genofond of the population as a factor vectorizing the selection for resistance to them; 3) selective physiological toxicity at the level of genera, species and biotypes leads to the stimulation of some species and to the inhibition of others, which sharply changes the natural course of microevolutionary processes in populations and the balance of the mutual relations of systems of organisms in biogeocenosis.

Essentially, all the three types of effect of pesticides on living things have the same final result, that is, a change in the population composition toward simplification, degradation and reduction. The genetic structure of cenoses as a whole, not only of individual species, is simplified. In turn this leads to an increase in the sensitivity of populations and cenoses to new unfavorable effects. The more complex and diverse the genetic structure of the cenosis, the greater the evolutionary plasticity that it possesses and the higher its buffering to the effect of ecofactors.

As a general conclusion of the analysis of the above-cited facts of the genetic activity of chemical compounds and, in particular, pesticides, the following statement will be valid. The study of the genetic activity of pesticides began comparatively recently, when a number of them were widely used and accumulated in the environment for a long time (DDT, aldrin and so forth). The existing methods of evaluation of genetic activity are still complicated, expensive and nonstandardized. At the same time, the mutagenic activity of some pesticides both with regard to microorganisms and for higher organisms, including man, was demonstrated by means of them.

At present there is an urgent and acute need for a detailed and profound study of the genetic effects of pesticides. An evaluation of the mutagenic and carcinogenic activity of newly synthesized compounds should be mandatory. In most cases (80 percent) mutagenic and carcinogenic activities coincide. Although the nature of malignant growth has not yet been determined reliably, its connection with mutagenesis is indisputable (Dubinin, 1976). Therefore, the "treated generation" suffers from mutations occurring in somatic cells and the progeny, from mutations in generative organs and gametes. Since many chemical mutagens are highly specific, for the screening of genetically active pesticides it is necessary to use a system of test-objects and methods.

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SPECIFIC LIFE SPAN DETERMINATION

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 246 No 2, 1979, pp 465-468

[Article by L. A. Gavrilov and N. S. Gavrilova, Moscow State University imeni M. V. Lomonosov]

[Text] The concept of specific life span (S. L. S.) which is based on the idea that the time of existence of organisms is genetically determined (1,2), has recently assumed extensive usage in the biology of aging. However, the S. L. S. has still not been determined precisely for any single biological species. The main difficulty in measuring S. L. S. is the fact that an organism's longevity depends not only on genotype but also on living conditions. Therefore the question as to the existence and measurement of a parameter characterizing a biological species alone--S. L. S.--still remains open.

This paper suggests a method making it possible to accurately measure specific life span of organisms for the first time. We define specific life span as a variable, measured in time, that does not depend on the living conditions and sex of an animal and which depends only on the biological species. We found that this variable does in fact exist, and that it may be computed from data on the mortality dynamics of organisms with respect to age. Thus, for example, for man, rats, and *Drosophila* the S. L. S. is respectively 98±5 years, 610±50 days, and 57±2 days.

The method of S. L. S. measurement consists of two stages of statistical treatment of animal mortality data.

1. Use of experimental data on mortality dynamics, with respect to age, to determine parameters R_0 and α in the Gompertz-Makeham equation

$$(1) \quad R_t = A + R_0 \exp(\alpha t),$$

where R_t is the probability of death, or the mortality of animals (the ratio of the number of animals dying to their initial number) at age t in the course of an arbitrarily set but constant time interval A ; R_0 and α are parameters of the Gompertz-Makeham equation. Formula (1) is a general law for animal death. Its validity has been proven for populations of people (3,4),

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horses (4,5), Dall sheep (5), rats (3,4), mice (5,6), houseflies (3,5), mosquitoes (5,7), and *Drosophila* (3,4). It should be noted that the Gompertz-Makeham equation has the proper theoretical grounds, and it can be derived by means of the mathematical machinery of reliability theory (3,8,9). These facts provide the basis for making broad use of this equation to analyze animal mortality statistics. In order to determine the values of parameters R_0 and α for people, we processed 285 abbreviated mortality tables, using data published by the World Health Organization (10) for all geographic regions of the world--Africa, America, Asia, Europe, USSR, Australia, and Oceania. We had described the method for computing R_0 and α in the Gompertz-Makeham equation earlier (3). It is much easier to compute coefficients R_0 and α for laboratory animal populations, inasmuch as A , which reflects background mortality due to causes not depending on age, can usually be ignored. Because when we plot the mortality logarithm ($\lg R_t$) against age (t) we observe a linear dependence, R_0 and α may be usually computed by the least square method. The results of such computation for fruitfly and rat populations are presented in tables 1 and 2. We can note that the dependence of $\lg R_t$ on t is in fact very close to linear. For fruitflies, in 88 percent of the cases this dependence had a correlation coefficient $r > 0.98$ (Table 1). A somewhat lower r was observed for rat populations, which is associated with the low abundance of these populations (135-288 individuals). Nevertheless the dependencies obtained had a correlation coefficient $r > 0.97$ in 80 percent of the cases (Table 2).

2. Computation of specific life span on the basis of correlations existing between coefficients R_0 and α :

$$(2) \quad \ln R_0 = M - B\alpha,$$

where M and B are parameters in equation (2) determined by the least square method. This dependence was first noted back in 1960 in a comparison of R_0 and α values for populations of people in countries typified by different mortality levels (4). However, a strict proof of equation (2) in relation to people was not given until 1978 (3). The same law was found to be valid in relation to rat and fruitfly populations (Table 3); consequently there are grounds for hypothesizing that equation (2) is a general law describing animal mortality. We had demonstrated earlier (3) that the meaning of equation (2) is as follows: For a given biological species and irrespective of the conditions under which it exists, all lines having the logarithm of age-dependent mortality ($\lg(R_t - A)$) and age (t) as their coordinates possess one common point of intersection (Figure 1). The coordinates of this intersection point correspond to parameters M and B of equation (2). It may be noted here that B is measured in time, that it does not depend on the conditions of existence (just due to the method of its computation alone), and that it does not depend on the sex of the animal (Table 3); consequently it characterizes only the biological species. Thus parameter B possesses all the properties of specific life span (S. L. S.), and the method we propose for computing S. L. S. permits us to objectively and accurately measure this variable in relation to animals of the most diverse classes.

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Table 1. Value of Parameters R_0 and α and Correlation Coefficient r For *Drosophila melanogaster* Populations*

$\alpha \cdot 10^4$, сутки ⁻¹ (1)	$\ln(R_0 \cdot 10^4)$ за 6 дней (2)	r	Диапазон ли- неаризации, дни (3)	Число точек (4)	Число дрозо- фил в популя- ции (5)	Источник данных (6)
(7) Самцы						
4,47	2,50	0,98	28-55	27	1000	(13)
6,35	2,19	0,98	25-55	6	1407	(13)
7,80	1,75	0,99	28-55	10	1200	(14)
9,31	1,50	0,99	28-55	10	2400	(14)
(8) Самки						
3,90	2,65	0,99	28-55	27	1000	(13)
5,93	2,16	0,97	25-55	6	1415	(13)
9,32	1,35	0,99	28-55	10	1200	(14)
13,07	0,36	0,98	28-55	10	2400	(14)

* Computed by us on the basis of published survival tables (12-14). The R_0 , α , and r values were determined by the least square method using coordinates $\ln R_t$ and t . A 6-day interval was chosen for mortality computation.

Key:

- | | |
|---------------------------------|---------------------------------------|
| 1. Per day | 5. Number of fruitflies in population |
| 2. For 6 days | 6. Bibliographic reference |
| 3. Linearization interval, days | 7. Males |
| 4. Number of points | 8. Females |

The principal theoretical result of our work is a strict proof of the existence of S. L. S., given for the first time. In fact, a number of important conclusions follow from just the fact of the existence of S. L. S. First, the correctness of the idea that life span is genetically determined. Second, we find that the rate of aging (or more accurately, the rate of irreversible age-dependent changes increasing the probability of death) does not depend for practical purposes on external conditions--that is, aging is based on a mechanism of the biological clock sort. This conclusion follows from all mathematical theories of aging (3,4,9) that permit existence of S. L. S. Third, it was found that the S. L. S. for man, rats, and fruitflies is significantly lower than the so-called maximum life span (M. L. S.) of these animals. therefore M. L. S. cannot be used to evaluate S. L. S., as is presently being done (2). Moreover indistinction from the situation with S. L. S., we cannot determine confidence intervals or preclude the influence of the environment and the sex of animals in relation to M. L. S. Finally, under otherwise equal

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Table 2. Value of Parameters R_0 and α and Correlation Coefficient r For Wistar Line Rat Populations*

(1) Год	(2) Самцы			(5) Самки		
	(3) $\alpha \cdot 10^3$, сутки ⁻¹	$\ln R_0 \cdot 10^3$ (4) за 100 дней	r	(3) $\alpha \cdot 10^3$, сутки ⁻¹	$\ln R_0 \cdot 10^3$ (4) за 100 дней	r
1956	4,62	1,23	0,96	5,00	0,90	0,97
1957	5,90	0,88	0,97	5,35	0,82	0,95
1958	6,75	0,58	0,92	3,28	1,19	0,81
1959	4,92	1,08	0,97	5,26	0,76	0,96
1960	7,44	0,37	0,99	6,10	0,54	0,99
1961	6,41	0,63	0,97	7,53	0,17	0,99
1962	4,48	1,14	0,97	7,23	0,22	0,98
1963	6,85	0,58	0,97	6,55	0,63	0,97
1964	6,76	0,61	0,98	8,31	0,10	0,99
1965	4,78	1,22	0,97	4,73	1,13	0,97

* Computed on the basis of published survival tables (11). Parameters R_0 , α , and r were determined by the least square method using coordinates $\lg R_t$ and t . The age interval of linearization was 300-750 days. Each dependence was determined with 10 points. A 100-day interval was chosen for mortality computation (R_t).

Key:

- 1. Year
- 2. Males
- 3. Per day
- 4. For 100 days
- 5. Females

conditions the size of M. L. S. must invariably depend on population size (namely, it must increase with growth in abundance). Consequently M. L. S. cannot be a characteristic of a biological species, in the same way that the time of decay of the last atom is not a characteristic of the radioactive element. Extensive use of M. L. S. in experimental gerontology was founded on the notion that there are specific limits to life. However, as Feller (15) showed, this idea is theoretically unsubstantiated. Thus in distinction from S. L. S., the value of M. L. S. has neither practical nor theoretical significance. As far as the practical significance of S. L. S. is concerned, it can be stated as follows for ecology and demography: Knowing the S. L. S., we can predict age-dependent mortality dynamics using just one or two prescribed mortality values.

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Table 3. Value of Specific Life Span for *Drosophila*, Rats, and People*

(1) Биологический вид	(2) Видовая продолжительность жизни $B \pm \sigma$, дни	Число точек (3) (пар R_0 и α)	Коэффициент корреляции (4) цмн между $\ln R_0$ и α
(5) Дрозофилы			
(6) самцы	50 \pm 5	4	-0.992
(7) самки	57 \pm 1	4	-0.9997
(8) оба пола	57 \pm 2	8	-0.995
(9) Крысы			
(6) самцы	660 \pm 40	10	-0.987
(7) самки	580 \pm 50	10	-0.968
(8) оба пола	610 \pm 50	20	-0.941
(10) Люди			
(11) мужчины	99 \pm 6 лет (13)	82	-0.914
(12) женщины	98 \pm 5 лет	82	-0.944
(8) оба пола	98 \pm 5 лет	164	-0.945

* Computed on the basis of data in tables 1 and 2. The R_0 and α values for people (164 pairs) are not presented here due to the limited space of this article.

Key:

- | | |
|--|---------------|
| 1. Biological species | 7. Females |
| 2. Specific life span, $B \pm \sigma$, days | 8. Both sexes |
| 3. Number of points (R_0 and α pairs) | 9. Rats |
| 4. Coefficient of correlation between $\ln R_0$ and α | 10. People |
| 5. <i>Drosophila</i> | 11. Men |
| 6. Males | 12. Women |
| | 13. Years |

In conclusion we feel it our pleasant duty to express our gratefulness to V. P. Skulachev, D. A. Karryeva, V. G. Semenova, N. I. Kuvakina, and all participants of the first symposium "Artificial Enlargement of Specific Life Span" for their moral support and valuable remarks during discussion of this paper.

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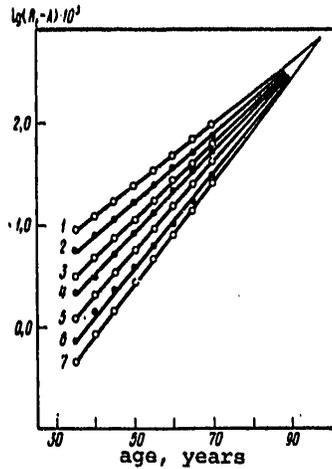


Figure 1. Dependence of the Logarithm of Age-Dependent Mortality, $\lg(R_t - A) \cdot 10^3$, on the Age of People. 1--India, 1941-1950, Men, $A = 7.87 \cdot 10^{-3}$; 2--Turkey, 1950-1951, Men, $A = 3.16 \cdot 10^{-3}$; 3--Kenya, 1969, Men, $A = 5.31 \cdot 10^{-3}$; 4--Northern Ireland, 1950-1952, Men, $A = 0.43 \cdot 10^{-3}$; 5--Great Britain, 1930-1932, Women, $A = 2.38 \cdot 10^{-3}$; 6--Austria, 1959-1961, Women, $A = 0.68 \cdot 10^{-3}$; 7--Norway, 1956-1960, Women, $A = 0.55 \cdot 10^{-3}$. Plotted on the basis of abbreviated mortality tables published in WHO annuals (10). The R_t and A values correspond to an interval of 1 year. A was computed using the formula $A = \frac{1}{4} \sum_{t=45}^{100} (R_t - R_0 \exp(at))$

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PHARMACOLOGY

UDC 575.224.4

ANTIMUTAGENIC ACTIVITY OF THE ANTICONVULSANT HEXAMIDINE. ACTION OF
HEXAMIDINE ON THE LEVEL OF SPONTANEOUS MUTATION OF A NUMBER OF OBJECTS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 246 No 2, 1979 pp 469-471

[Article by G. N. Zolotareva, E. A. Akayeva, and R. I. Goncharova, Scientific
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[Text] The human population is rather highly saturated with negative
mutations. In this connection we found it interesting to reveal antimutagenic
action in medicinal preparations broadly employed in clinical practice
without genetic harm.

This paper examines the first detection of an antimutagenic effect in the
convulsant hexamidine, acting upon spontaneous mutation in mice, fruitflies,
and spring onions.

Hexamidine (primidone, desoxyphenobarbitone) is a barbituric acid derivative,
an anticonvulsant, and a pure preparation produced by the Leningrad Pharma-
cochemical Plant. Male CBA x C57Bl/6 hybrid first-generation mice weighing
20-22 gm, 2 months old, were subjected to mutation tests using somatic and
embryonic cells. The bone marrow cell metaphase analysis method (1) and the
dominant-lethal test (1) were employed. Hexamidine was injected intra-
peritoneally once as a 1 percent starch suspension at doses of 400 mg/kg
(about half of the LD₅₀ for mice), 100, and 25 mg/kg. Exposure times when
working with bone marrow were 12, 24, and 48 hours. Berlin line *Drosophila*
melanogaster was studied for the frequency of arisal of recessive sex-linked
lethal mutations (Meller's method 5) (2). The frequency of partial and
complete deletions of sex chromosomes were studied in (R (1)2, yv/sc⁸ JB^S
line *Drosophila* males. Imagoes were processed with hexamidine at 6 and 12 mM
concentrations. The preparation was dissolved in dimethylsulfoxide (DMSO),
and exposure time was 2 days. When larvae were processed with hexamidine at
concentrations of 0.01, 0.005, and 0.0005 M, a suspension of the preparation
was introduced into standard medium.

Sprouts of spring onion seeds stored for 1 year were used to determine
chromosomal aberrations in anaphase cells in response to hexamidine at

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concentrations from 1 to 0.1 mg/ml. the preparation was dissolved in DMSO drops. The control consisted of distilled water and DMSO drops. The seeds were grown in hexamidine solution for 48 hours. Then the sprouts were rinsed off and transferred for subsequent growth to dishes containing distilled water. They were fixed 65 hours after growth began.

It was demonstrated in dominant-lethal tests carried out on mice in three independent experiments that when mature sperm is exposed to hexamidine at 400 and 100 mg/kg doses, postimplantation mortality and the number of aborted embryos per female decreased significantly in comparison with control ($P < 0.05$) (Table 1). As we know, these indices are said to be basic to determining genetic effects in the dominant-lethal test.

Within the zones studied, hexamidine did not influence natural mutation of cells in mouse bone marrow. When the material was fixed 12, 24, and 48 hours after the time of administration of the preparation, the yield of aberrant metaphases (about 1 percent of the number examined) and the spectrum of damage (single fragments) in experimental samples corresponded to the control.

Table 1. Action of Hexamidine in the Dominant-Lethal Test on Mice

(1) № опыта	(2) Доза, мг/кг	(3) Число самок	(4) Доимплантацион- ная гибель, % $\pm m$	(5) Число мерт- вых эмбри- онов на 1 сам- ку	(6) Постимплантацион- ная гибель, % $\pm m$
1	400	23	11,16 \pm 2,1	0,30	3,64 \pm 1,4
	100	23	10,29 \pm 2,1	0,26	3,27 \pm 1,3
	25	20	14,36 \pm 2,6	0,40	5,16 \pm 1,8
2	(7) К	21	10,22 \pm 2,3	0,71	9,5 \pm 2,3
	400	45	17,56 \pm 1,7	0,27	2,9 \pm 0,8
3	К	47	17,17 \pm 1,6	0,57	6,2 \pm 1,2
	400	32	7,14 \pm 1,5	0,37	4,39 \pm 1,2
	100	40	8,66 \pm 1,6	0,35	4,74 \pm 1,3
	К	35	8,82 \pm 1,6	7,97	9,70 \pm 1,7

Key:

- | | |
|--------------------------------------|---------------------------------------|
| 1. Experiment number | 5. Number of dead embryos per female |
| 2. Dose, mg/kg | 6. Postimplantation death, %, $\pm m$ |
| 3. Number of females | 7. Control |
| 4. Preimplantation death, %, $\pm m$ | |

It was demonstrated earlier (3) that at a concentration from 6 to 0.1 mg/ml, hexamidine reduces the level of natural mutation in meristem cells of spring onion sprouts. The fact that hexamidine had an effect within such a broad interval of doses attests to its highly effective antimutagenic action. Judging from the ratio of basic categories of chromosomal alterations in experiment and in control, the preparation suppressed natural cell mutations without having a specific effect on any particular category of alterations. Similar data have been published for a number of antimutagens such as

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Table 2. Effect of Hexamidine on Spontaneous Mutability of *Drosophila melanogaster*

	(1) Концентрация, мМ	(2) Стадия обработки	(3) Число изученных хромосом	(4) Число летальных мутаций	
				абс. (5)	% ± m
(6) Гексамидин	6	(9) Имага	2581	0+2	0,08 ± 0,05*
(6) Гексамидин	12	"	1494	3	0,20 ± 0,11
(7) Диметилсульфоксид	-	"	1166	1+2	0,26 ± 0,14
(8) Контроль	-	"	2399	6+1	0,29 ± 0,10
(6) Гексамидин	0,5	(10) Личинки	3375	2	0,05 ± 0,04*
(8) Контроль	-	"	4468	11	0,25 ± 0,07
(6) Гексамидин	5	"	636**	2	0,31 ± 0,12
(6) Гексамидин	10	"	-***	-	-
(8) Контроль	-	"	2911	6	0,21 ± 0,06

* P<0.05

** Low imago yield.

*** Total absence of imagoes

Key:

- | | |
|----------------------------------|----------------------|
| 1. Concentration, mM | 6. Hexamidine |
| 2. Processing stage | 7. Dimethylsulfoxide |
| 3. Number of chromosomes studied | 8. Control |
| 4. Number of lethal mutations | 9. Imagoes |
| 5. Absolute | 10. Larvae |

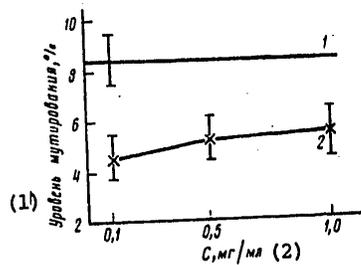


Figure 1. Action of Hexamidine on Natural Mutation of *Allium fistulosum* L.: 1--Control, 2--experiment

Key:

- | | |
|----------------------|-------------------------|
| 1. Mutation level, % | 2. Concentration, mg/ml |
|----------------------|-------------------------|

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streptomycin, ionol, β -karotene, and others. It may be hypothesized that hexamidine produces its effect prior to arisal of true chromosome breakages. This is indicated by data from two independent experiments in which hexamidine was rinsed: At concentrations from 1 to 0.1 mg/ml the preparation had a significant antimutagenic effect (Figure 1).

In experiments on fruitflies, in which the frequency of recessive sex-linked lethal mutations was determined, the decline in spontaneous mutability was significant ($P < 0.05$) when fruitflies were processed in both the postmeiotic stages (adult imagoes) and the premeiotic stages (larvae) of spermatogenesis (Table 2). These data show that hexamidine, an antimutagen, is effective in this test in relation to the action of both replicating and nonreplicating sex cells. The metabolic conditions experienced by these cells are dramatically different. Therefore the mechanism behind the antimutagenic action of hexamidine in different stages of fruitfly spermatogenesis may differ. Hexamidine is a derivative of barbituric acid, close in structure to pyrimidine bases. The possibility is not excluded that hexamidine is capable of interacting with DNA, possibly through substitution at the nucleotide level. Hexamidine displayed no activity against fruitfly males according to test data representing the frequency of partial and complete sex chromosome deletions.

In sum total, the materials presented here show that the anticonvulsant hexamidine is an antimutagen with a broad spectrum of action. It reduces the level of natural mutation in three species of higher organisms--mice, fruitflies, and spring onions, having an influence on formation of different categories of mutations (chromosome and gene).

Data indicating that hexamidine has antimutagenic activity are especially important in light of reports that other anticonvulsive medicines--benzonal and karmomazepin--are mutagenic (1,3).

Revelation of mutagens and antimutagens in a series of preparations having similar pharmacological action would permit medical practice to utilize preparations not harboring a genetic danger.

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PHYSIOLOGY

UDC 612.821.6

CONNECTION OF RECALL TACTICS AND BASIC INDICATORS OF MEMORIZATION AND RECALL PROCESSES IN RESPECT TO SPOKEN MATERIAL

Moscow DOKLADY AKADEMII NAUK SSSR in Russian, Vol 245 No 6, 1979, submitted 8 Dec 78, pp 1504-1507

[Article by L.N. Vinogradova, Scientific Research Institute for Biological Tests of Chemical Compounds of the Settlement of Kupavna of Moscow Oblast (Presented by Academician O.G. Gazenko, 23 Feb 78)]

[Text] In the last 10-15 years, research in the area of memory of spoken material was associated, to a large extent, with the development of models, which explain the facts and basic mechanisms of functioning of this form of memory. The mechanisms of the basic phenomena of memory of spoken material, studied, as a rule, under conditions of an ordinary experiment on memorization and free recall of lists of similar verbal elements, was depicted as a certain set of standard conversions which are completed with the material remembered in the short-term memory and the long-term memory /1,2/. The results of such conversions usually were presented in the form of a memorization - recall curve, which reflects the dependence of probability of recall of a word on its place in the list shown. Characteristic ascents of the curve (increase of probability of memorization - recall) in the initial and end parts, designated as the effect of primariness and the effect of recentness, associated with reflection of the dynamics of processes of long-term memory and short-term memory. This did not deal with the problems concerning the presence and the role of active operation of the subject with the memorized material in terms of these indicators. This study is an attempt to verify the hypothesis that basic parameters of the memorization - recall curve are determined, to a considerable degree, by the nature of the activity of the subject who is remembering and by the tactics of recall (memorization) he uses.

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PROCEDURE. In three series of experiments, examinees memorized, in sequence, 15 lists of the same length: 12 words in the 1st series, 20 words in the 2d series and 30 words in the 3d series. The lists of words (unassociated, frequently encountered, 2-complex singular number nouns, nominative case) were presented by tape recorder at a frequency of one word every 2 seconds. Preliminary instructions were: immediately after listening to the lists of words, name any words in any order which you remember. Reproduction of each list was limited to 1 minute. On the basis of summation and averaging of the results of recall by the examinee of the list presented, we constructed dependence curves of the probability of recall of a word on its location in the list (curves of memorization - recall). For comparison of the degree of pronouncement of the effect of primariness and the effect of recentness (best memorization and reproduction of words at the beginning and the end of the list) we determined the maximum probability of reproduction of words occurring in the first 3 words and the last 5 words, respectively and constructed confidence intervals by the Neyman method /3/.

Variation by the examinee in the course of the experiment of the order of reproduction of words from the lists presented was considered as an indicator of use by the examinees of different tactics of reproduction (tv) and, possibly, memorization, for it did not depend naturally in any way on the characteristics of the list and conditions of the experiment. On the basis of the preferred presentation at the beginning of reproduction (first 3 words) of words from different parts of the list, we isolated the different methods (tactics) of recall: beginning of recall 1) at the beginning of the list (tv_1); 2) in the middle of the list (tv_2); at the end of the list (tv_3). In case all three parts of the list were represented uniformly in the first 3 words of reproduction (one word from each part of the list), tv was determined by the word, reproduced first. We compiled the frequency of use by examinees of different tactics for recall of the list presented sequentially and the values of effects of primariness and recentness, which characterize memorization -- recall of these lists.

Examinees included 68 healthy persons with secondary or higher education: 20 persons (mean age 29 ± 8 years) in the 1st series, 28 persons (mean age 32 ± 10 years) in the 2d series and 20 persons (mean age 27 ± 8 years) in the 3d series of experiments.

* The list is divided: beginning - first 3 words; end - last 5 words; middle - all words except first 3 and last 5.

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Table 1
Indicators of Reproduction of Lists of Words by Different tv

(1) № п.л.	(2) № серии опытов	(3) Т.а. л.	(4) эффект первичности		(5) эффект незначности		(6) n ^{**}	Воспроизведение слов средних списков		
			величина (7)	доверительный интервал (8)	величина (7)	доверительный интервал (8)		средняя веро- ятность (9)	доверительный интервал (б)	10
1	I	2	3	4	5	6	7	8	9	10
1	I	1	120	0,89	0,82-0,94	0,67	0,50-0,75	480	0,30	0,26-0,34
2	I	2	27	0,56	0,38-0,73	0,70	0,52-0,84	108	0,57	0,48-0,67
3	I	3	153	0,41	0,33-0,49	0,92	0,87-0,95	612	0,17	0,13-0,21
4	II	1	104	0,86	0,79-0,90	0,54	0,44-0,63	1248	0,16	0,14-0,18
5	I	2	89	0,39	0,30-0,49	0,53	0,43-0,62	1068	0,26	0,24-0,28
6	I	3	227	0,30	0,25-0,36	0,93	0,88-0,96	2724	0,17	0,16-0,18
7	III	1	20	0,75	0,55-0,88	0,55	0,36-0,73	440	0,13	0,10-0,16
8	I	2	87	0,16	0,10-0,25	0,57	0,47-0,66	1914	0,20	0,18-0,22
9	I	3	193	0,28	0,23-0,34	0,87	0,82-0,90	4246	0,14	0,13-0,15

Key:

1. Page number
2. Number of series of experiments
3. TV
4. Effect of primariness
5. Effect of recenctness
6. Recall of words in the middle of the list
7. Value
8. Confidence interval
9. Mean probability

* n₁ - number of lists being reproduced

** n₂ - number of words in the middle of the list being reproduced

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Table 2

Dynamics of Different tv and Magnitudes of the Effects of Primariness and Recentness in the Course of the Experiment

(1) № з.п.	(2) № серии опытов	(3) № опыта	(4) Число воспринятых элементов	(8) % воспринятых элементов			(9) Эффект различности			(10) Эффект новизны			(11) Эффект недавности			(12) Коэффициент интервала		
				1-й	2-й	3-й	1-й	2-й	3-й	1-й	2-й	3-й	1-й	2-й	3-й	1-й	2-й	3-й
I	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
I	1	1	20	85	10	5	0,95	0,60-0,97	0,60	0,40-0,77	0,60	0,40-0,77	0,60	0,40-0,77	0,60	0,40-0,77	0,60	0,40-0,77
I	2	2	20	30	15	55	0,65	0,45-0,81	0,75	0,55-0,88	0,75	0,55-0,88	0,75	0,55-0,88	0,75	0,55-0,88	0,75	0,55-0,88
I	3-15	3	260	37	9	54	0,58	0,52-0,64	0,82	0,78-0,86	0,82	0,78-0,86	0,82	0,78-0,86	0,82	0,78-0,86	0,82	0,78-0,86
II	1	1	28	68	25	7	0,93	0,79-0,97	0,46	0,31-0,62	0,46	0,31-0,62	0,46	0,31-0,62	0,46	0,31-0,62	0,46	0,31-0,62
II	2	2	28	36	35	29	0,61	0,44-0,76	0,64	0,47-0,78	0,64	0,47-0,78	0,64	0,47-0,78	0,64	0,47-0,78	0,64	0,47-0,78
II	3-15	3	364	21	20	59	0,41	0,36-0,48	0,78	0,74-0,82	0,78	0,74-0,82	0,78	0,74-0,82	0,78	0,74-0,82	0,78	0,74-0,82
III	1	1	20	35	35	30	0,70	0,50-0,84	0,55	0,36-0,73	0,55	0,36-0,73	0,55	0,36-0,73	0,55	0,36-0,73	0,55	0,36-0,73
III	2	2	20	0	40	50	0,30	0,25-0,42	0,80	0,60-0,91	0,80	0,60-0,91	0,80	0,60-0,91	0,80	0,60-0,91	0,80	0,60-0,91
III	3-15	3	260	5	28	67	0,23	0,18-0,30	0,79	0,73-0,85	0,79	0,73-0,85	0,79	0,73-0,85	0,79	0,73-0,85	0,79	0,73-0,85

- Key:
1. Page number
 2. Number of series of experiments
 3. Number of list
 4. Number recalled
 5. Percent of recalled
 6. Effect of primariness
 7. Effect of recentness
 8. tv₁
 9. tv₂
 10. tv₃
 11. Value
 12. Confidence interval

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RESULTS OF THE STUDIES. During study of the connection between the nature of the memorization - recall curve and tv in each series of experiments, results of reproduction of all lists were separated into 3 groups according to the tactics used. On the basis of summation and averaging of results of recalls in each of these groups, we constructed memorization - recall curves, which characterize the results of use of different tv. Table 1 presents results of statistical processing of these materials. As follows from the data obtained and from Table 1, the use of tv_1 in all 3 series of experiments corresponds to a reliably higher (than during other tv) effect of primariness (compare lines 1 and 2 and 3, 4 and 5 and 6, 7 and 8 and 9 of columns 4 and 5 Table 1), which in this case greatly exceeds the effect of recentness (inverse ratios are considered characteristic). Reproduction with the use of tv_3 revealed the greatest (in comparison with other tactics) effect of recentness (compare 3 lines and 1 and 2, 6 and 4 and 5, 9 and 7 and 8 of columns 6 and 7 of Table 1) and relatively little effect of primariness. During use of tv_2 , the effect of primariness is represented approximately the same as during tv_3 (compare lines 2 and 3, 5 and 6, 8 and 9 of columns 4 and 5 Table 1) and the effect of recentness, the same as during tv_1 (compare lines 1 and 2, 4 and 5, 7 and 8 of columns 6 and 7 Table 1). The mean probability of recall of words from the middle of the list, ^{**} in this case, significantly exceeds the value of this indicator for other tv (compare lines 2 and 1 and 3, 5 and 4 and 6, 8 and 7 and 9 of columns 9 and 10 of Table 1). The probability of recall of individual elements represented by increases on the memorization - recall curve are comparable to the value of effect of primariness or exceeds it.

Results of the study of the interconnection of tv and the degree of pronouncement of effects of primariness and recentness on the course of the experiment are presented in Table 2 which presents the characteristics of memorization - recall of the 1st, 2d and 3d - 15th ^{***} lists in each of the 3 series of experiments by all examinees. Analysis of data of the Table show that reduction in the course of the experiment of use of tv_3 (column 5 Table 2) is accompanied by a drop of the effect of primariness and an increase of the effect of recentness (compare lines 1 and 2; 1 and 3; 5, 4 and 6; 7 and 8; 7 and 9 of columns 7 and 8 and 10 of Table 2). The distribution of recall in conformity with the tactic used is associated with the number of words in the memorized list as follows: the longer the lists (12--30 words) the less often the examinees used tv_1 and the more often recall involved the use of tv_3 (lines 3, 6, 9 of columns 4 and 6 Table 2).

^{**}In distinction to effects of primariness and recentness, recall of the middle of the list was evaluated not by the maximum probability of recall of any word but by the results of averaging the indicators of recall of all words of this part of the list.

^{***}Table presents averaged indicators of memorization - recall of lists 3-15, since, beginning with the 3d list, the process displayed sufficient stability

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At the same time, there is an inverse dependence between the number of words in the memorized list and the degree of pronouncement of the effect of primariness (lines 3, 6, 9 of columns 7 and 8 Table 2).

Thus, in the experiments conducted, it was possible to postulate the active attitude of the examinees toward the material presented in the memorization - recall process, for, in the course of one and the same experiment, there was noted shifts to different tv by each examinee beyond the regular connection with this tv and changes of them were evaluated as an indicator of the activity of the subject (including that outside of the sphere of consciousness). It was established that the nature of this activity (using tv) has a significant effect on the shape of the memorization - recall curve; tv_1 is associated reliably with a higher effect of primariness, tv_3 is associated with a higher effect of recentness and tv_2 with best reproduction of words in the middle of the list. The use of this or that tv not only increases the corresponding effects but also changes the importance of other components of the memorization - recall curve. Therefore, we may conclude that what is recalled well is recalled first. The authors of study /4/ came to a similar conclusion on the basis of other experiments.

Everything said above justifies the assumption that a regular change of tv during lengthening of the list of words (rejection of tv_1 in favor of tv_2) lies at the basis of the previously observed /5/ and confirmed in this experiment inverse dependence of the value of the effect of primariness on the length of the list memorized.

Results of this experiment raise the problem of the necessity for considering the factor of the activity of the subject who is memorizing during interpretation of basic indicators of the memorization - recall curve and construction of models of memory of the spoken word. In particular, this concerns the rise of the effect of primariness and the recentness and the reflection in them of the temporary organization of short-term memory and long-term memory. As was seen, even in a standard posing of the experiment with the purpose of calculation and analysis of memory in the "pure" form, a vital role is played frequently by the activity of the subject which is unrecognized and unforeseen during construction of the experiment.

Discussion of the facts obtained in a neurophysiological plane is difficult at present. We can only assume that they are associated, evidently, with processes of control of consolidation of traces, understood in a broad sense, including organization of traces in some structures, which facilitate subsequent reading.

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PSYCHOLOGY

THE PSYCHOLOGICAL SERVICE IN THE USSR: ITS OBJECTIVES, CONTENT, AND ORGANIZATION (A ROUNDTABLE DISCUSSION)

Moscow VOPROSY PSIKHOLOGII in Russian No 2, 1979 pp 1-26

[Text] The lead article in this journal's first issue this year stated the intention of the editorial board of VOPROSY PSIKHOLOGII to publish, in 1979, a roundtable discussion of some problems in psychological science of importance to further development of Soviet psychology and to introduction of its achievements into various practical areas. Fulfilling this intention, the journal's editorial board publishes, in the present issue, a discussion of one of the topics proposed in the article mentioned above--namely the issue as to the so-called psychological service in various areas of our society's life, mainly in the national economy (the psychological service in the production sphere--at individual enterprises or in industrial administrative agencies and in other areas of our country's national economy), in national education (at its various levels--in schools of general education, in vocation-technical schools, in tekhnikums, and in VUZ's), and in public health (in various types of therapeutic institutions).

The proceedings of a conference sponsored at the end of 1978 by the USSR Academy of Sciences Institute of Psychology in response to instructions from the USSR Academy of Sciences Presidium to develop proposals on organizing a psychological service in our country served as the starting point for discussion of this topic. In addition to participants of this conference, some other authorities of Soviet psychological science were asked to join this roundtable, and their opinions are also published in the present issue. Naturally the limited size of this issue prevented the editorial

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board from inviting a number of other of our country's psychologists (working in the practical areas indicated above) whose opinions should be of considerable interest, as well as representatives of other practical spheres to state their points of view (a situation that must be corrected). This shortcoming can be easily eliminated by publishing the appropriate articles in a subsequent issue of the journal.

Let us now turn to the content of statements made by participants of this roundtable discussion.

Yu. M. Zabrodin (USSR Academy of Sciences Institute of Psychology, Moscow)

I would like to begin discussion of the psychological service with the reasons for organizing it--by singling out the following four aspects bringing together the basic organizational-scientific, legal, material-financial, and personnel issues of this means for introducing psychology into practical activities.

Organizational-scientific issues: These issues stem from the mutual relationship of "theory, experimentation, and practice" in psychological research, which means, first of all, a need for determining the scientific meaningfulness of the problems being worked on, and their practical orientation; second, it means a need for determining the demand for psychology and psychologists by the principal sectors of the national economy, and the priorities for introducing the psychological service into these practical areas; third, it means a need for determining possible modifications of the structure and objectives of the psychological service in relation to each national economic sector with a consideration for its unique features.

Moreover it is impossible to build a unified psychological service in the country without first sensibly organizing its material-technical base. Unfortunately the job of producing domestic resources to support psychological research has not been completed yet, and we have not been able to arrive at scientifically grounded evaluations of the dependability and usefulness of the resources available. These problems require not only discussion in psychological institutions but also special constructive solutions; they require creation of centers of scientific methodology and commissions created with the objective of developing recommendations and methods for introducing research results accounting for the specific conditions of production and, equally so, monitoring their introduction and determining their economic feasibility. It would apparently be suitable to create a number of scientific-production centers having the job of planning, developing, and initiating series production of the necessary support equipment. Next, the organizational-scientific issues are such that we must generalize the experience of the psychological service in our country and abroad: We must thoroughly analyze the activity of these services and the experience in applying psychological methods; we must examine the progress that has been achieved, and the

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possible shortcomings in the work. A number of issues of organizational-scientific nature pertain to the status of psychological science, to its readiness for solving concrete practical problems in various sectors. These issues must be resolved by defining the practical problems and then suggesting practical scientific programs bringing the psychological service (embodying for the moment the practical activity of introducing the achievements of psychological science into the national economy) closer to the scientific, the academic aspect. We will know that psychology is ready in this regard when academic psychologists are able to relate their scientific developments to the acuity of the problems which arise in the national economy and require solution by psychological science. Experience has shown that psychology is already in a position to solve major practical problems with a tangible social and economic impact (estimated in the millions of rubles in a number of cases). Such is the case, for example, with introduction of some schemes of scientific organization of labor in production and of management of production collectives, developed under the guidance of the USSR Academy of Sciences Institute of Psychology. Such is research on operator activity, occupational selection, and production training being conducted on the basis of basic findings in general psychology and the general theory of labor psychology and engineering psychology.

Analysis and evaluation of information displays in complex control systems have made it possible to develop practical recommendations on their planning and on ways to reduce operator training time.

Psychological analysis of the work of fishermen on long cruises resulted in development and introduction of new work schedules aboard commercial fishing vessels. These are just a few examples of introduction of the results of psychological research into the practical activities of the country's national economy, examples which demonstrate the possibilities and real effectiveness of such work.

Organizational-legal issues: These issues include, first of all, those of determining the official positions and status of psychological service workers, of determining their rights and responsibilities, which would require participation of lawyers and labor and wage specialists in these and, equally so, other legal issues. These issues also include the problem of legal interaction between psychologists and professionals in the corresponding sector of the national economy: Should the psychological service be subordinated to the given sector, or should we create a special centralized organization responsible for managing the service? In the former case we would encounter the problem of scientific surveillance over the activity of this service. There is another organizational-legal problem that would inevitably arise as well--certification, selection, and advanced training of workers in the psychological service.

Material-financial problems--the financing and financial accountability of the psychological service. The experience of other countries shows that a psychological service can work to a significant extent on a khozraschet

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basis. But to arrive at a concrete solution to this problem we would have to resolve a number of particular issues concerning the financing of research and, specifically, the psychological service, and concerning payment for consultation, expert analysis, diagnosis, and other forms of work.

Personnel training issues make up the most important link in implementation of the psychological service. Only a few institutions in our country are training professional psychologists today and even so, with rare exceptions, the graduates of psychological VUZ's are not prepared for work in the psychological service. This is why the issue of selecting specialists for work in this system and training them, mainly in VUZ's offering the appropriate specialties, is especially important. Thus far the approaches to solving these problems are highly primitive. Thus Yaroslavl' University possesses a school of industrial applied psychology which following minor reorganization could take on the job of providing special training to psychologists for the psychological service. However, to arrive at a complete solution to this problem we would have to reorganize VUZ training and define the ideal specialist.

Other issues of no less importance are those of training and retraining specialists already working in industry, upgrading psychological specialists, and providing special psychological training to professionals in various national economic sectors.

The content of the psychological service includes different forms of occupational activity.

Diagnostic and prognostic activity: The natural application of this form of activity embraces the problems of social, occupational, personal, and individual diagnosis and prognosis. Some scientific and methodological experience has already been accumulated here, but we need to dramatically broaden the front of the work and concentrate the efforts of academic psychologists in various specialties.

Activity in mental hygiene and consultation: This area includes various levels of preventive psychology and professional consultation defined in the broad sense. What I am implying is preventive and consultative medical psychology, preventive and consultative social psychology, production hygiene, occupational orientation, occupation selection, rehabilitation in the presence of deviations, adaptation to activity, and an entire series of other questions, for many of which we unfortunately still do not have clear theoretical answers.

Normative-standardizing activity: In regard to this form of activity, psychologists have accumulated a significant amount of experience in engineering psychology and some in medical psychology. I am implying various regulatory documents--methodological letters, recommendations, norms, and sector and state standards. However, for the most part this work has pertained to extremely particular applications and to narrow aspects of practical activity:

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The existing developments involve particular problems, and most standards pertain to the manufacture and use of specific implements and resources of labor. Standardization of methods and research procedures is a forgotten problem.

Expert activity--psychological expert certification in different sectors of the national economy. This form of activity already enjoys practical applications to some extent in forensic, medical, and engineering psychology, and to a lesser extent in labor psychology. However, development of unified methodological and scientific grounds for psychological expert certification has not been completed yet.

Planning activity, associated with development of complex and supercomplex sociotechnical systems. Let me recall that in most of its applications, in the end engineering psychology must become a planning discipline, but the level we seek consists of not only the planning of complex and supercomplex systems with which we deal in a particular area of our scientific-technical progress, but also with the planning of new and promising forms of human activity. Introduction of psychological planning must begin with assimilation of the entire arsenal of occupation analysis methods; however, we have not as yet managed to generalize the experience of psychological description of human activity. As a result we lack a good psychological classification of the forms of human activity, nor do we have enough dependable resources permitting us to evaluate them from a psychological standpoint, or scientifically grounded ways for optimizing and planning existing forms of professional activity and new types of occupations.

Research: This includes determining the problems, structures, perspectives, and the most important directions of scientific and practical research arising in connection with the activities of the psychological service in various sectors of the national economy, and in connection with the developmental prospects of these sectors. It also includes special research on scientific methodology associated with selecting, testing, adapting, and carrying over the scientific results of laboratory work (or of foreign experience) into real practice. Fundamental research and a clear methodology have an especially conspicuous role in this case, inasmuch as this is the area where progress is often most evident.

Let us consider the basic spheres of the psychological service.

Education: This includes the entire spectrum of the psychological problems faced by our schools, from primary schools to VUZ's. Unfortunately this sphere of the psychological service is unable to satisfy practical needs fully, though the scale of scientific research concerning scholastic problems is great and the results of this research are being introduced into practice to one extent or another. The network of institutions in the system for occupational selection, training, and consultation (for example enterprise advisory offices) is not sufficiently developed. The objectives of the psychological service lack unity of structure and unity of definition

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and, consequently, unity of their solution. There are also problems associated with interdepartmental coordination.

Production: This includes industry, agriculture, transportation, and communication. This sphere contains various sector organizations and institutes (in some sectors) dealing with labor protection and scientific organization of labor. Special psychological laboratories have been organized in certain industrial sectors and major enterprises. There are centers that deal with the problems of scientific organization of labor, social planning, and development of enterprises and sectors.

However, there are problems in that, on one hand, the AUCCTU possesses a separate and rather extensive network of central and sector research organizations dealing with the problems of labor protection and labor analysis (it has a central institute and on the order of 10 peripheral institutes with their own psychological divisions), while on the other hand the State Committee for Labor and Social Problems is creating a network of similar institutions. These problems are aggravated by the fact that every ministry and every sector, understanding the importance of psychological problems, is creating its own sector laboratories and laboratories serving the principal enterprises.

Public health: It is perhaps precisely in this sphere that the experience of utilizing psychological knowledge in the real activity of specialists has been accumulated and systematized to a certain extent. There is an official medical psychologist slot, legalized by an order of the minister of public health. According to this order persons not possessing a special psychological education cannot fill this slot. This ministry has an extensive (in structure and manpower) network of institutions associated for the most part with the diagnosis and therapy of various mental disorders. The Institute imeni Bekhterev, psychiatric clinics, neurosurgical institutes, and organic pathology and nervous disease clinics are the principal representatives of practical psychology in medicine. However, psychologists working in such institutions use basically foreign methods for diagnosing and analyzing pathological personality alterations, be they adapted to our country's conditions.

This necessitates broader development of the methodological, theoretical, and experimental-practical problems of personality psychology. I am referring not only to psychosocial aspects but also to the general psychology of the personality. Without solving these problems we cannot understand and evaluate the diverse methods of psychological diagnosis and therapy, mainly those used in the clinic. However, even though solution of this problem in the purely theoretical aspect depends on practical interaction between psychologists and medical specialists, a common viewpoint has still not been developed in this area as yet.

The legal sphere: I am implying the entire system associated with jurisdiction, jurisprudence, law, and its application and protection. Research has been

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Going on in this area for a rather long time (it experienced dramatic intensification in recent years), practical interest in this area has evolved and taken form, and more or less clearly outlined objectives have been revealed. The most important problems of this sphere are those pertaining to abnormal behavior, abnormal personality development, and preventive social psychology. It should be emphasized that much attention is now being devoted to the task of humanizing our legal agencies (the nature of correctional institutions; analysis and correction of the criminal psychology; problems concerning adaptation or readaptation of offenders to social conditions). At the same time the practical results enjoyed in this area are still insufficient to fully reveal the fundamental principles for building a psychological service in this system.

Sports: The demand for practical psychologists working with athletes is growing and it is being satisfied in part. A large amount of practical experience has been accumulated, but unfortunately it is basically experience in working with team sports and with athletes at higher proficiency levels. Psychologists have not had enough experience yet with popular sports: We need to work some more on dependable psychological methods for selecting promising athletes and methods for evaluating the influence of popular sports on the public's mental health.

As in other spheres, once again there is a problem of centralizing and coordinating practical and scientific work. Interest in sports psychology, which has grown significantly in recent years, has made development of research in this area urgently needed.

There are two scientific research centers in Moscow--the All-Union Scientific Research Institute of Physical Culture and the Central Scientific Research Institute of Physical Culture--that are doing work in sports psychology. At the Leningrad Institute imeni Lesgaft this work is being done by one of the largest and oldest departments of psychology (in sports). However, a number of pressing problems still remain unsolved.

Art: It is extremely difficult to consider organization of a psychological service in this sphere: On one hand there is a complex of problems that have been totally ignored from the scientific aspect, while on the other hand people working in the theater, films, television, and musical culture are experiencing a colossal need for psychological knowledge. Several art schools offer courses in psychology, and some theatrical studios employ psychologists who evaluate and prepare actors and provide assistance to directors. Rather extensive (though particular) research has been done in musical acoustics and music perception.

Given all of this, a gap between the psychological problems in art that must be solved and the real advances psychology has made in this area is becoming clearer and clearer.

Services: An enormous amount of research experience has been accumulated in this area abroad, to include experience in psychological analysis of

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advertising, demand, and market conditions. There are numerous psychological problems, especially in connection with growth of individual needs on one hand and growth of the number of people in service occupations on the other. In particular, one of the most complex and important problems--forming or nurturing needs--is only just beginning to be solved in the psychological aspect: We have yet a long way to go before its practical solution. Meanwhile it is directly associated with the problem of regulating demand and market conditions, demand and needs, and a number of other problems.

Creation of a psychological service presupposes organizing psychologists specializing in various spheres of human activity. Psychologists analyze the products of human activity and the means and object of labor from different aspects. But man as a subject of labor, his harmonious development, and the specific laws governing his activity continue to be the paramount concerns of the psychological service. At the same time psychological analysis of the products of labor and the problem of upgrading the quality of these products and the criteria for evaluating it are acquiring special importance. One of the activities of the psychological service concerned with this area is expert certification of the usefulness of the products of labor and of their correspondence with various standards, to include psychological recommendations. The goal of this activity is to see that a product of labor is planned with a consideration for the society's needs and the possibilities for satisfying them.

Expert psychological certification acquires specificity when the product of activity is a resource of labor. The principles followed in expert psychological certification of labor resources, which are relatively well developed now, were discovered through research by domestic engineering psychology: The resources and methods of expert certification of the labor resources themselves have been worked out, the problems and ways of improving these resources have been defined, and some standards and regulatory documents have been adopted.

The work of the psychological service is organized differently in relation to the subject of labor. Analysis of the subject of labor necessarily presupposes psychologically grounded organization of the subject's work-rest schedule. The problem is made complex by the fact that we know a rather great deal about man at work but little about man at leisure. And yet sensible organization of the work-rest schedule and psychologically grounded recreation for the subject of labor harbor tremendous reserves for raising labor productivity and guarantee harmonious development of the personality.

Different forms and methods of organizing the activities of the psychological service must be employed in relation to problems arising at the interface of the resources of labor and the subject of labor. I am referring to humanization of labor, to raising its effectiveness and productivity. The experience of domestic psychology has shown that application of psychological knowledge results in a decrease in losses occurring in the production process. Some of the results of applying this knowledge include accelerated specialist

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training, combination of sensible selection and training, joint optimization of work schedules and the resources of labor, control of occupational and social adaptation, and improvement of social relationships at work.

We will need new ways for organizing the activities of the psychological service when it comes to practical introduction of research results in relatively new directions of applied psychology, directions for which activity planning is a special form of labor, one taking account of the unique features of human activity and including psychologically grounded planning of equipment, production processes, and work schedules for a given individual and for a given form of activity.

There is yet another specific facet of relationships which requires a unique response in the work of the psychological service. I am referring to the organization of the subjects of labor in modern production, to organization of production collectives and their management, to the specific psychological features of management, to personnel placement problems, to cooperation and division of labor, to moral and material stimulation, organization of socialist competition, to assessment of the psychological climate, to optimization of management, and to selection and training of executives.

In conclusion I would like to briefly evaluate that which has been done to organize the psychological service, or some of its subservices. We have already accumulated and generalized the experience of psychological engineering and medical subdivisions, which can be referred to conditionally as spontaneously evolved but which are the core or skeleton of the psychological service. A somewhat tentative attempt has been made to generalize the experience and examine the directions and principles of organizing an engineering psychology service at production, with a consideration for the effectiveness with which psychological specialists could be utilized in the staffs of scientific organization of labor divisions, or in labor protection divisions, or in an independent group working at the enterprise, in a laboratory servicing a series of enterprises or, finally, in sector institutes.

A considerable amount of positive experience has already been accumulated in organizing a medical psychology service. We now have a network of institutions in this service, and proposals concerning the organization of the psychological service have been suggested. Organizational schemes have been proposed which account for the work experience of professional consultation services.

We have not as yet accumulated sufficient experience in solving the problems of a psychological service having as its goal practical solution of problems concerning the collective, management of the collective, and relationships within the collective. We can clearly see that not enough experience has been accumulated yet by organizations dealing with the problems of socioeconomic planning and social development of collectives; these organizations do employ socialists, physiologists, economists, and specialists in scientific organization of labor, but unfortunately they do not use the services of professional psychologists.

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I would once again like to note the important significance of parallel (with practical work), intensive development of fundamental research in the principal areas of psychological science as that methodological basis of the psychological service. This means that as we develop the psychological service and solve its problems, we will encounter two groups of problems:

Revision of long-range plans and programs of fundamental psychological research, relying on integrated, programmed, specific planning;

integrated planning of scientific practical and organizational work aimed at building and developing the psychological service.

V. V. Davydov, D. I. Fel'dshteyn, and D. B. El'konin (USSR Academy of Pedagogical Sciences Scientific Research Institute of General and Pedagogical Psychology, Moscow)

Whether or not we can raise the effectiveness of education in institutions of the national educational system will depend significantly upon the practical work done by professional psychologists. This work must consist, first, of constant surveillance over the course of child mental development with the objective of determining the effectiveness of the content and methods of education in the school in relation to different categories of students, prevention of deviations in their development, and development of measures promoting fuller development of the capabilities of schoolchildren; second, of psychological diagnosis of problems occurring in mental development of the individual, and of clarifying the psychological structure of these problems and the measures of pedagogical correction adequate to them; third, of psychological consultation provided to adolescents and young adults undergoing occupational orientation and selecting their occupations.

In recent years our country has performed scientific research aimed at clarifying the tasks of psychological diagnosis and at developing the methods of its use in each of the tasks indicated above. We are beginning to see more and more clearly in this regard that the individual child viewed as an object in a particular stage of development, the structure of deviations in his mental development and behavior, and the system of correcting pedagogical measures proposed on this basis are the principal object of psychological diagnosis. The pedagogical correction measures presently being implemented in the schools basically boil down to supplementary lessons or to disciplinary measures, which do not as a rule provide the needed impact. These methods of correction can be called symptomatic, aimed not at the "disease" but only at individual symptoms, which may be the same for developmental disorders in the child that differ in psychological structure. Corrective measures planned on this basis are not sufficient on their own, and they may not produce the needed impact. Research on schoolchildren must be broader and deeper; it must reveal the roots of deviations from proper behavior or study seen in the given schoolchild. The methods we use for diagnosing mental development must be developed with psychological-pedagogical consultation in mind; this necessarily presupposes that we determine the psychological

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structure of disorders, their origins, the possible corrective measures, and the ways for monitoring their effectiveness. Completion of these tasks would be truly successful only on the invariable condition that we achieve unity in diagnosis and corrective education--that is, in a special institution where we could monitor the immediate and long-term results of this work (this institution must be a unique "clinic" dealing with disorders in normal development in children in different age periods).

Creation of such institutions will permit us to intensively develop modern methods of psychodiagnosis to be applied in support of consultation, as well as to determine the profile of the professional consulting psychologist, capable of working within the institutions of national education themselves. In our opinion the improvement experienced by the entire Soviet system of education in the next few years must be based on a sufficiently extensive network of institutions in a school psychological service.

A. A. Lyublinskaya (Leningrad)

The issue of creating a school psychological service is an urgent one, and it requires thorough discussion, since there is much in this area that is unsolved and uncertain. First of all we should note that the psychologist presently participates in the work of the school as an official school psychologist, as a colleague of a special regional (section) center of medical psychology, or as a director of scientific research at such a center. The responsibilities of a psychologist employed in an official capacity at a school (nursery, boarding school) must include: a) immediate analysis of schoolchildren under his supervision (by teachers and educators): The strong and weak points of each child, and especially his trainability, and the progress enjoyed by the child in each quarter and year with the goal of organizing the composition of classes sensibly and developing (jointly with the teachers) individual approaches when so required by the schoolchildren; b) determination, once again jointly with teachers, Pioneer leaders, and especially the class teacher and the school physician, of a special "life regimen" for individual children needing it; c) analysis of the child's life in the family, provision of advice to parents concerning the living conditions to be afforded to the child, and implementation of other measures tailored to the child's needs; d) analysis of the most realistic "promising aspects" of the child's development--his interests and inclinations, his motives of learning and behavior, and his mutual relationships with peers and with adults; e) analysis of the class (Pioneer detachment, and so on) from the standpoint of its function as a collective, with the goal of improving and raising its effectiveness as a means for educating each member; f) organization and provision of broad job training and, in grades VII-VIII, occupational training having the purpose of occupational orientation; g) organization and conduct, for senior schoolchildren, of a series of lectures, discussions, and meetings on the problems of self-education; their familiarization with main psychological concepts, phenomena, and laws, expansion of their general philosophy and scientific outlook, and achievement of greater depth in the knowledge senior schoolchildren have of man, of his vital activities, of his role in the life

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and development of society, and of the laws governing personality development; h) organization and conduct of systematic work with teachers, Pioneer workers, and librarians aimed at raising their general knowledge of child psychology and development; i) conduct of regular lectures for parents and consultation with parents; j) participation in pedagogical councils during discussion of the behavior, academic success, and individual problems in the life and activity of schoolchildren. The responsibilities of a regional (section) psychological center or center of medical psychology must include the following functions:

Consultation in relation to especially difficult cases requiring additional (in excess of what is provided by the school) medical and psychological examination; publication of conclusions and recommendations, coupled with analysis of the subsequent effectiveness of the recommendations and analysis (in the event that their effectiveness is lacking) of the reasons for their groundlessness, and of the ways for raising their effectiveness;

regular meetings held with practicing psychologists on individual problems in their work, and analysis of concrete measures, recommended in relation to individual students, with the goal of raising the responsibility and proficiency of the school psychologist acting as a diagnostician-researcher and a participant in the work of shaping the personalities of the children being studied;

analysis and generalization of the work experience of school psychologists with the goal of systematizing this work in a certain way, and developing and testing out diagnostic methods and recommended individual approaches (on the basis of an analysis of concrete facts describing the well known Pavlovian "environments");

improvement of the scientific qualifications of school psychologists participating actively in the school's educational work, especially in regard to preventing and surmounting learning and education difficulties of individual students.

Regional (section) psychological centers (offices, laboratories) must be staffed by qualified psychologists having experience in research and practical psychology and having a good awareness of the school, its day-to-day work and, equally so, the work of the school psychologist. Such an institution must be headed by a scientist with high qualifications possessing considerable experience in research on children. Not only teachers, educational managers, and school directors but also workers of extracurricular institutions, libraries, Pioneer leaders, and active Komsomol members must be encouraged to work at the center as its active participants. All of these workers must meet together either in each school quarter or at least once every half year to discuss certain problems of the center's or school psychologists' work. Every center colleague must be officially assigned to particular schools as a consultant. They must be given supervision of junior colleagues (their number depending on the total number of schools to which

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services must be provided) conducting additional research in the schools, acquainting themselves directly with the work of school psychologists, and preparing all necessary materials for their discussion at the center.

The plan outlined above for providing psychological services to the schools will naturally require a significant amount of work to train psychologists specializing in children's psychology and possessing the necessary knowledge and practical work skills. The work of improving the techniques for multifaceted examination of the child must assume tremendous significance. Life persuades us that until such time that a real need for such techniques arises, their development, elaboration, and testing for dependability will continue to proceed extremely slowly. With introduction of practical work by the psychological service, however, which will require dependable techniques, the work of creating them will proceed much more fruitfully. It is entirely natural for us to demand that such work should proceed consistently and that those doing it should display the deepest responsibility for it. The experience of many other countries (Poland, Bulgaria, and so on) shows that this work can be done by specialists already being trained in our country. All we need do is organize all of this work. It is urgently required by the well-being of our children, and it is a prerequisite to improvement of school operation. And if a psychological service is organized in our schools in the next few years, this will be a significant contribution to the highly important objective of nurturing the new man--the builder of communist society. In the current year, the Year of the Child, noticeable efforts must be made to arrive at positive solutions to problems concerning organization of a psychological service in the school.

N. A. Menchinskaya (USSR Academy of Pedagogical Sciences Scientific Research Institute of General and Pedagogical Psychology, Moscow)

The question as to the need for organizing a psychological service has long been a crucial one in school education. We definitely need intermediate levels between research psychologists and practical teachers, ones which we do not have today. This is retarding and hindering introduction of the results of scientific research into school practice. Meanwhile pedagogical psychology has already accumulated many results deserving introduction into school practice, ones which would doubtlessly promote improvement of training and education. But we must refrain from broadly introducing different forms of psychological service from the very beginning. There must be a period of transition (at least for the next few years) during which this service would operate on a limited scale. The reason for this caution lies in the fact that the practical psychologist must accumulate a certain amount of work experience, the methods of his work must be tested out some more, and we must reveal the shortcomings present in the training of the practical psychologist and the improvements that must be made in his training.

It would presently be suitable to create psychologist slots not in each school but rather in the rayon and city public education divisions. The

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premises governing the practical work of psychologists in these divisions and the organizational forms of the work must be developed. The psychologist's practical activity must be aimed mainly at helping the teacher to study the psychological features of the students. Such help can be provided in the following forms: a) Analysis of the students by the psychologist himself, b) systematic expansion of the experience teachers have in analyzing the students and c) improvement of the methods of such analysis. Schoolchildren causing difficulties of a particular sort to the teacher in training and education have a special need for deep psychological analysis. In this case the psychologist must not limit himself to simply asserting particular features of the personalities of the students being analyzed; instead, he must sit down together with the teacher and plan the ways to correct the shortcomings.

One of the important tasks of the school psychologist is to develop (jointly with teachers) the most effective individual approaches to students. In this connection the psychologist's attention must be oriented at improving the characteristics of schoolchildren of importance to the teacher. Occupational orientation must become a special direction in the psychologist's work. This work includes professional consultation as a means for helping the students to achieve self-determination. It would also be desirable for psychologists to participate in the work of school subject commissions. A mandatory prerequisite of the psychologist's success would be publication of the appropriate manual on methods for studying schoolchildren. In this case we must consider analysis of students not only by a psychologist but also by the teacher in the course of his work. We also need to develop and recommend experimental procedures to be used by psychologists.

A. I. Kitov, A. M. Stolyarenko (Academy of the USSR Ministry of Internal Affairs, Moscow)

The most important task posed by the 25th CPSU Congress is to fight for effectiveness and quality of labor in all spheres of our development--in the national economy, in education, culture, science, public health, social development, and in services. Psychological science can and must play an important role in this task. One of the most important forms of direct assistance which psychology could provide to practice is organization of a psychological service supporting both individual institutions, enterprises, and educational and therapeutic organizations on one hand and central administrative agencies and the administrations of different practical areas on the other. Nor are internal affairs agencies an exception in this regard in our country, since there are many extremely pressing problems saturated with a psychological content in their activities directed at preserving social order, fighting crime, rehabilitating offenders, preventing road accidents, and so on.

Without going into a full description of all of the directions of the psychological support required, let me indicate just a few of them. First of all we need help in discovering crimes, in conducting investigations, in

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establishing who had committed the crime, in determining the motives of criminal actions, and--this is very important--in arriving at a general description of the criminal personality. The task of analyzing and evaluating testimony by witnesses, which far from always correctly reflects reality, and which on the contrary deviates from reality to one extent or another precisely due to some psychological reasons, is most intimately associated with conduct of an investigation, being one of its inherent components. Here as well an experienced psychologist can provide significant help.

The next direction in psychological work is participation in crime prevention. After all the individual's behavior and his personality traits that create the soil for crime depend on the given individual's way of life, the psychosocial atmosphere in the collective in which he works, the entire psychosocial climate influencing him, and his extrication, in time, from surroundings which have a systematic negative influence on him. As practice has shown, it is only by considering this and taking the appropriate preventive steps that we can truly eliminate the conditions that prod the individual to assume a life of crime. The work associated with this direction is of course not easy: What we need is an entire complex of measures, and participation of psychologists in their development and in implementation of the most effective ones.

We know quite well that a significant proportion of crimes are being committed by persons in a drunken state with the goal of satisfying a need for alcohol that has become persistent. It may be said that parasitism, the reluctance to work and live an honest life, has a close kinship with this problem. If we are to reveal the causes of alcoholism and parasitism and determine the ways for surmounting these problems, which serve as the grounds for violation of social order, once again we must demand integrated work by representatives of different specialties, to include psychologists.

We have a special need for psychologists to participate in work with juvenile offenders, mainly adolescents. The crimes they commit can often be explained by the harmful influence of adult criminals who exploit, for their own self-interested goals, the mental instability of adolescents, their desire to be "adults," to imitate adults, and to follow their example.

A third and, once again, extremely important direction of practical activity by the psychologist is that of developing effective measures for correcting and rehabilitating convicts. Success here depends to a great extent on the psychosocial atmosphere in which the convicts find themselves, on the individual approach taken to each of them, and on the ability to account for the past of each convict, for finding that "key" that would open the door to his personality, his experiences. Restructuring the convict's personality is a complex psychological task necessarily requiring the participation of professional psychologists in addition to other specialists.

Let me briefly state some of the concrete issues in organizing a departmental psychological service. In my opinion it must be organized as a hierarchically

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controlled system with levels of administration coinciding with those of the department's administrative structure. The functions of the psychological service cannot be limited to those of analysis, research, consultation, and so on, since this would hardly be enough support to a department interested in the practical results being achieved by its institutions. The psychological service will have to earn its right to exist by having a positive influence on the characteristics used to evaluate the department's activity, and this would be possible on the condition that it assumes a certain degree of responsibility for the state of affairs in the department.

We obviously cannot create a departmental psychological service all at once, since there are financial, organizational, personnel, and scientific problems needing time for their solution. I believe that we should begin by reorganizing, as a controllable system, the activity of the departmental psychological subdivisions and individual psychologists already present. Creating large psychological scientific research centers out of the small ones now in existence is a pressing task, but one which essentially requires no additional outlays. This will make it possible to plan the activities of the psychological service, the functions of its divisions and representatives, and the methods of its work.

The service must obviously be a scientific-practical service, and it is in this that we find one of its most important distinguishing features.

Creating the central administrative machinery of the psychological service is an important organizational step. Only with its presence can we provide direction to and solve many financial, economic, organizational, personnel, and scientific problems.

And, finally, one of the most important issues is personnel training. What we need for practical work and, all the more so, to complete the tasks listed above, is a special type of psychological specialist, and we must train him in a special way. He must be a psychologist specializing in the problems of the department by which he is employed--a sociological psychologist, a pedagogical psychologist, or an organizational psychologist. Such specialists can apparently be trained as special groups in schools of psychology, and representatives of the appropriate department must be encouraged to participate in the training program. Though perhaps not today, it will soon make sense to create special psychological-pedagogical schools in training institutions or in the departments requiring practical psychological assistance, a specially organized psychological service.

M. M. Kabanov (Leningrad Scientific Research Institute of Psychoneurology imeni V. V. Bekhterev)

I will dwell on development of the basic directions of medical psychology. I would need to emphasize in this case that we define medical psychology as a sector of applied psychology and medicine utilizing the achievements of

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psychological science for the purposes of diagnosing, treating and preventing diseases. The development and course of diseases depend on both somatic and mental factors, and they usually elicit a mental reaction in the individual. Medical psychology should be thought of as a necessary part of medicine (diagnosis, therapy, and prevention); it must be relied upon in all of its sectors, in each of which psychology solves specific problems posed by the logic of scientific development of the given theoretical or clinical sector of medicine. This is precisely why the main goal of the psychological service in public health is to encourage psychologists to participate in programs of therapy and rehabilitation containing the various sorts of correctional (medical-pedagogical) measures implemented in relation to patients, their families, and their production collectives (to include the collectives at therapeutic institutions). This brings up the question of improving the system for training medical psychologists in the universities. We must reexamine the medical psychological training programs for physicians, since this training does not at all satisfy today's needs. The article "Social Psychology and Instruction of Psychiatry and Medical Psychology" by Yu. Ye. Rakhalskiy published in 1978 in the ZHURNAL IMENI KORSAKOVA states the need for considering the achievements of social psychology, particularly in regard to those problems of medical education where the psychosocial principle is the most important (the level of the personality, self-awareness, interpersonal relationships, compatibility, the so-called psychological climate, value orientations, and many other problems). These problems also have a direct bearing on the training of psychologists for public health. I would single out the problems of psychodiagnosis as the principal sphere of application of the professional capabilities of psychologists.

The number of psychological studies being conducted in a number of theoretically and practically significant areas of modern medicine--in the clinical pattern of psychoneural and especially psychogenic diseases, in research on psychosomatic disorders, in rehabilitation and psychotherapy, and so on--has grown dramatically in recent years. The amount of empirical information of various levels, obtained in clinical practice by means of various psychological techniques, is increasing, and the number of psychological techniques being employed is rising. However, often when we perform psychological research we ignore a fundamental methodological principle: The method must be compatible with the research objective and the theory behind the objective being sought. In these conditions, further development of the theory and practice of psychodiagnosis, to include test theory, acquires great significance. The experience of the Institute imeni V. M. Bekhterev has shown that if we are to create testing techniques, we would need a significant effort by a collective of physicians, psychologists, and mathematicians for a period of a number of years. We presently possess a set of standardized methods for psychological analysis of the personality, developed here in our country or adapted from the best foreign tests. In the hands of an experienced, qualified psychologist, they are doubtlessly an important auxiliary resource for studying the patient's personality. Naturally the tests must be given in integration with other methods. This also affords a possibility for maintaining individual clinical control.

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We also need to develop instrumental psychophysiological analysis methods as well as automated systems for collecting and processing experimental data. Use of automated information systems in psychodiagnosis is opening up extensive possibilities for creating a certain bank of techniques that are adequate and valid in relation to experimental psychological research in various fields of medicine. In my opinion, more work must be done today to solve problems traditional to psychiatric, neurological, and neurosurgical clinics (in topical and differential diagnosis, evaluation of the structure and degree of psychoneural disorders, diagnosis of mental development, evaluation of the dynamics of psychoneural disturbances and determination of the effectiveness of therapy, expert certification, and some other tasks). I am referring to the problems of studying the personality, the social microenvironment, and the patient's system of attitudes with the purposes of arriving at a functional diagnosis and creating a foundation for psychological correction and rehabilitation of patients. The conception of functional diagnosis, which has been taking shape in recent years, is a concrete embodiment of the systems approach to the patient, viewing the personality and the disease in their unity. Functional diagnosis of mental illness must include three aspects: 1) Clinical, characterizing the type of course, the stage of development (the degree of compensation), and the structure of the defect; 2) psychological, reflecting the personality at different levels of its development (its structural-dynamic features, orientation, the system of value orientations, and so on), and characterizing the patient's attitude toward the disease, toward the situation associated with it, and toward the possible consequences (the internal pattern of disease), as well as the mechanisms and level of psychological compensation, and other features; 3) a social aspect, which must give us an idea of the patient's premorbid situation and the unique features of his social and work adaptation (presence of a profession, his qualifications, his status in the production collective and in small groups, to include the family, the particular features of his communication with others, persistence of his social ties, and so on). While the clinical aspect gives us an answer to the question as to what is disturbed and to what degree, the psychological and social aspects tell us who it is that is disturbed and under what circumstances.

This approach to the problem is acquiring special urgency today, and in many ways it is the product of development of the conception of patient rehabilitation as a new approach to the sick individual, one having general medical significance. Rehabilitation must not be limited in his case to the objective of restoring individual mental functions; it must be viewed as integrated activity directed at restoring the patient's personal and social status (completely or partially) by a special method mainly entailing exertion of therapeutic and restorative influences via the personality. As a method for approaching the sick individual, rehabilitation is most intimately associated with mental correction, with psychotherapy. The medical psychologist must work with the physician to get a good understanding of the patient's system of attitudes and be able to correct it in association with the tasks of psychotherapy and rehabilitation. The psychologist's role is

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especially significant in creation of a therapeutic environment, which we define as organized life in the therapeutic institution, where all mutual relationships and mutual dependencies of its members are subordinated to psychotherapeutic goals.

Psychotherapy, especially group psychotherapy, which has diverse forms, to include psychotherapy within the family group, is one of the most adequate methods of patient rehabilitation (resocialization). As many authors validly emphasize, as a therapeutic method it is principally a general medical discipline. Because of the clear interdisciplinary nature of this field, which is developing at the interface of medicine, physiology, psychology, sociology, pedagogics, and other sciences, not only physicians but also psychologists and sociologists must participate actively in the development of its theory and in its practical implementation. We can find an example of their work in research on the laws governing group dynamics, research on the problems of empathy, and research on other problems important in the development of the theory of psychotherapy and rehabilitation.

Another important subdivision of medical psychology is the complex of problems pertaining to research on the nature of so-called psychosomatic diseases, on the methods for treating such diseases, and on ways to prevent them. The work experience of the Institute imeni V. M. Bekhterev in Leningrad, of the psychological subdivisions of the USSR Academy of Medical Sciences Institute of Cardiology, the Kaunas Medical Institute, and other institutions has shown that participation by psychologists in research aimed at studying the role of mental processes and states, interpreted as factors mediating and regulating social and environmental influences upon the somatic sphere of the individual, is very effective.

While arising and development of the conception of emotional stress and recognition of its significance to psychosomatic illness was in itself one of the paths of development of this direction, this same conception is now going a long way to define and stimulate another direction of medical psychology--the study of psychological adaptive mechanisms the individual employs in response to persistent stressful influences at work and in personal life. Medical psychological and psychosocial research performed in this area must be oriented at mental hygiene and prevention of mental illness.

There is one more sphere of activity for psychologists in medicine--medical pedagogics, the significance of which was emphasized by V. N. Myasishchev. If we are to solve the pressing problems in this direction, we would need to conduct experimental psychological and neuropsychological research (diagnosis of mental development, type of character accentuation in adolescents, revelation of disturbances in higher cortical functions, and so on). We need to develop methods of psychological correction and rehabilitation for sick children and their families (substantiated by preliminary clinical and medical psychological research) and, finally, we must subject so-called difficult children and adolescents to psychological preventive and correctional measures.

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The psychologist's work with the physician is especially effective in family psychotherapy. The family is a unique sort of small group. Therefore we can view the work of a psychotherapist (physician, psychologist) with a family as a form of group psychotherapy. From a historical standpoint family psychotherapy came into being before the practice of discussing the patient's medical history with relatives with the goal of amplifying it. But such contacts of the psychotherapist with the family group acquire fundamentally new content and significance when not only the individual but also the entire family group, the entire range of counterproductive interactions between family members becomes the object of concern.

In recent years we have observed intense development of medical psychology as a science, and introduction of its achievements into practical public health. This has been the product of reorganization of the entire system of Soviet public health, with emphasis on achieving broad use of the rehabilitation approach to the patient. This is creating favorable preconditions for further development of medical psychology. The success of this development will depend on creative cooperation among representatives of different sciences--physicians, educators, and other specialists.

B. V. Zeygarnik (School of Psychology, Moscow State University)

Theoretical and practical psychology have grown much closer in recent years; thus decisions of the 25th CPSU Congress on intensifying the role of science in development of communist society are being implemented. One of the most important practical areas with which psychological thought comes in contact is medicine (especially some of its sectors such as psychiatry and neurology).

An orientation not only on therapy but also prevention of disease, on the social aspects of the doctor's work has always been a traditional distinguishing feature of Russian medicine. During the years of Soviet rule this humanitarian trend assumed paramount importance. The CC CPSU and USSR Council of Ministers decree "On Measures for Further Improvement of National Public Health" (September 1977) spells out the principal tasks in this area. Most importantly, we must assume an orientation toward prevention and early detection of diseases, and discovery of scientifically grounded methods of restoring and correcting the personality, and returning the sick individual to life and labor. Medical practice has especially great demands in relation to pathopsychology, which is now facing a number of pressing problems--correction and rehabilitation, diagnosis, expert certification (forensic, labor, military), developmental abnormalities in children and adolescents, and psychopharmacology. We should consider, however, that the requirements being imposed by social clients are for the most part defined by practical needs rather than by the possibilities possessed by psychology and psychological practice today. Psychologists are now being trained for medical practice in the psychology school of MGU [Moscow State University], Leningrad State University, in Kiev, Tartu, and Tbilisi, and in some other cities of

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our country. On graduating from the universities, they work fruitfully in different areas of medical practice. In the future, however, the demand for such specialists will increase dramatically. According to just data obtained by MGU's school of psychology from the USSR Ministry of Public Health, the psychiatric service will need more than 1,000 psychologists in the next 5 years. The tasks they will face are diverse, but they will mainly involve 1) acquisition of experimental data, as a supplement to clinical data, helping to amplify the diagnosis, and 2) evaluation of the type and degree of intellectual and motivational disorders. This division of the work is very important, since forms of disturbances that are often identical in their external manifestations differ in their origin and structure. Thus, for example, the nature of communication disturbance taking the form of "autism" may be different for a schizophrenic and for a neurotic or a so-called difficult adolescent. Correspondingly the steps taken to correct this defect must differ depending on the structure of the disturbance.

Forensic psychiatric expert certification is an area that senses a great need for a psychological service (especially when such certification is hindered by actions of the patient which may quite definitely have disease at their origin). It should be noted that it is frequently easier to reveal the integrity of pathology of the personality through psychological experimentation than through discussion with the patient. The same pertains to labor certification, where patients often dissimulate their shortcomings and continue to insist upon holding jobs in occupations or specialties no longer suited to them. The psychologist plays a significant role in military expert certification of potential draftees. In addition to mild degrees of debility, they sometimes are able to reveal subtle symptoms of disorders in thinking or other forms of mental activity, which transforms expert certification into a starting point for timely treatment of young people.

Going on, the psychologist must participate in research on preschool children exhibiting doubtful progress in preschool development, such that the form and degree of mental underdevelopment could be established (to permit selection of the type of school training required in the future). We also need psychologists to study so-called difficult children (including those that do perform well in public schools) with the goal of developing corrective measures (consultation with parents, teachers, and educators). Help from psychologists is needed in research on adolescents and young adults with a weakened nervous system so that help could be provided in selection of a speciality and in occupational orientation. I must emphasize that qualified occupational orientation is more important to them than to healthy children. The same should be said for organizing work rehabilitation of disabled persons, and equally so for research on patients suffering pathology caused by harmful production factors.

The psychological service in medicine broadened significantly in recent years, and psychologists are now assuming broader responsibilities in medical practice: Psychological research results are being introduced into the clinical treatment of not only mental but also somatic diseases (cardio-vascular, oncological, renal, and so on). As far as the content of

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psychological work is concerned, the following should be said in its regard: The practice of somatic medicine is posing tasks to psychology boiling down basically to studying the personality, its attitude toward disease and toward its self-awareness, and its capacity for criticism, to revealing changes in dominant activity, to finding substitutions for frustrated activity, and to finding ways to correct all deviations from normal. The tasks posed by medical practice to psychology are diverse, and their solution requires professional knowledge and skills. Answers to the questions of medical practice must be prepared by psychological science using psychological concepts and categories, in the language of psychology's conceptual machinery. And if we are to introduce them into practice in all of the directions indicated above, we would need a large number of psychologists knowing how to work in practical medicine, ones who are well acquainted with the theoretical and methodological problems of psychology and, at the same time, aware of the real requirements and nuances of practical medicine. Unfortunately there are still not enough such personnel, and owing to this lack psychologist slots are being filled by people without a basic psychological education and requiring retraining; moreover the latter must be deep and quite substantial, which means a lot of time. There is one more fundamental issue that must be stated: It is sometimes said in our country that psychological services are more developed abroad than here, and that we must not fall behind. Of course we must persistently expand our psychological service, and we must deepen it, but this should not be done simply by uncritical transfer of the methods and data of foreign psychology. Our domestic psychology is fundamentally different from foreign psychology. The paths of development we follow are different. Soviet psychology is based on Marxist philosophy, and it has an ideological function not only in theory but also in practice. Therefore the content of practical psychological service would have to be different as well: Most important to us is nurturing a conscious personality that is mature and capable of self-control; medical practice requires that psychologists have the ability to analyze the forms and manifestations of altered motives, value orientations, and the nature of cognitive activity, and equally so they must be able to find the ways of work and social readaptation. It is not our function to "sort" people, as is done in foreign medical psychology; instead, our task is to raise the level of personality development, to surmount psychological shortcomings existing in it, and to achieve maximum development of all of the personality's strengths and capabilities. Considering the ideas of Soviet psychology concerning ontogenetic development of mental processes and personality features, we must use different methods and interpret the research results in a different way. We have such methods now, they have been tested out, and they are reliable.

It is also very important for institutions of higher education to devote considerable attention to the psychological service in medicine. The MGU school of psychology has begun a considerable amount of important work aimed at reexamining course content, and it is taking steps to expose students to more practical work. I feel that the Central Council of the Society of Psychologists must also get together with psychologists in practical medicine and think about the ways for broadening the psychological service in medicine;

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inasmuch as the number of specialists with a basic psychological education (these are the only sort of specialists that could provide a real benefit to practice) cannot be increased significantly in the immediate future, gradual growth in their numbers must be provided for. Were psychological services to be provided to practical medicine by people ignorant of the theoretical fundamentals of our psychology and its methodology and unequipped with the numerous tools of psychological knowledge, harm could be done not only to medical practice but also to psychological science itself.

V. D. Shadrikov (Yaroslavl' University)

Analysis of the basic socioeconomic tasks formulated in the Party Program and elaborated upon in decisions of the 24th and 25th CPSU congresses would show that psychological science can make a significant contribution to their completion. This pertains first of all to nurturing a thoroughly developed personality, to propagandizing the socialist way of life, to accelerating scientific-technical progress, to improving socioeconomic planning, to raising labor and sociopolitical activity, to organizing socialist competition, to raising the effectiveness of management, and to achieving sensible use of manpower (occupational orientation, selection, and training, optimization of working conditions and improvement of industrial safety, improvement of the entire system of education, and so on).

We can confidently say that there is a social need for creating a psychological service in our country.

Is the national economy ready to accept specialists in psychology? The experience of working with business contracts and of psychologist training in the country's universities allows us to answer this question positively as well. VUZ psychology departments are conducting scientific research costing tens of millions of rubles. Calculation of economic effectiveness would show that 1 ruble invested into psychological research produces from 2 to 10 rubles profit. The country's schools of psychology receive requests from enterprises and departments for their graduates every year. There are now examples of young psychological specialists creating psychological laboratories in industry and dealing successfully with the problems of production organization and control.

At the same time it should be noted that an inadequate psychological service significantly reduces the impact from scientific research and hinders introduction of scientific research results into practice. Much still depends on the personality of the director of the given enterprise, on the extent to which he is persuaded of the need for utilizing psychological data in the solution of pressing management problems. Nor is everything right with the way graduates of psychology schools are being utilized. Their status at enterprises is uncertain, their rights and responsibilities have not been worded precisely, and material support is not being provided to research and to introduction of recommendations.

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As a rule the present problems in production organizations are complex, and they can be solved only through the joint efforts of specialists of different profiles, to include psychologists. To solve these problems, we need time and materiel. This must not be forgotten when the discussion turns to introducing psychological science into the national economy. There are sectors that do exhibit a greater interest in utilizing specialists in psychology. They should provide more material support to their training in institutions of higher education.

A comprehensive examination of the issue of introducing a psychological service in our country would require that we go beyond analyzing just the external reasons making its introduction suitable. Its introduction into the national economy would also be useful in terms of the development of psychological science itself. It will help us to eliminate the still-existing shortcomings in the work of scientific research institutions and in the work of educational institutions: Irrelevance of theoretical research to pressing economic problems, and of theoretical research to applications; insufficient development of the tools of psychological diagnosis. Nor can we say that psychologist training in the universities is perfect yet. College students still lack textbooks for the principal fundamental courses (general psychology, experimental psychology), as well as for specialized courses in which the student's professional countenance is formed (labor psychology, social psychology, the motivations of labor, occupational orientation, occupational selection, occupational training, and so on). Instruction of specialized lecture and laboratory courses is excessively theoretical: The students fail to assimilate the tested techniques for solving today's problems.

However, the dialectics of the relationship between theory and practice prevent us from solving the problem on the basis of an approach from science alone. Science must test its recommendations out in practice, and for this purpose it must have the appropriate organizational support.

V. A. Ivannikov (MGU School of Psychology)

Psychology in our country is presently experiencing a unique period--gradual transformation into a practical specialty. A large number of psychological laboratories are already operating in the country's clinics and industrial enterprises, in design offices, and in various institutions, in which the colleagues of these laboratories are solving pressing practical problems.

In this connection institutions of higher education training specialists in psychology now face the extremely important task of altering the profile of the training--broadening preparation of students for practical activity: This will require corresponding review of training plans and programs. To be successful in this work, we would have to finalize the requirements for specialists in different sectors of psychology. The departments of the MGU's school of psychology have now determined the requirements for different specialties. This required considerable effort: Department representatives had to meet with many requestors of school graduates, analyze the performance

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data of students serving 1-year apprenticeships in places of work, and organize meetings with graduates of various classes at the school. All of this work revealed a number of difficulties in practical psychological work, which can be subdivided into two categories--difficulties associated with the forms of training given to students in the school, and difficulties associated with organizational issues at places of practical work and with the methodology available to psychological science itself.

Because the school's training plan was oriented at preparing scientific researchers first of all, students did not develop sufficient habits of independent practical work. It was found that students have poor facility with the procedures for setting up questionnaires, that they have a poor knowledge of the corresponding tests and are unable to work with them, that they experience difficulties in developing other techniques of applied research, that they lack the skills of expert evaluation, that they do not know how to envision the psychological problems faced by the given sector, and that they do not understand the language of specialists with whom they must work.

Objective difficulties in practical work include: Absence of quick methods for evaluating the state of an individual, individual mental functions, personality traits, intelligence, occupational suitability, and so on; a lack of experience, hindering communication with workers in the sector and with the managements of institutions and enterprises; management's ignorance of the possibilities of psychology and its inability to pose tasks to the psychologists and spell out definite instructions; poor work methods, devised as a rule by persons other than psychologists; absence of books on psychology comprehensible to nonspecialists and, as a consequence, absence of a common language between specialists in the sector and psychologists.

These shortcomings require effort on the part of both workers of institutions of higher education and institutions concerned with psychological theory. Universities training psychologists must change the training provided to students; institutions specializing in theory, meanwhile, must broaden their applied research so as to provide guidance to the practical work of psychologists and make it possible to make psychology not only a scientific discipline but also a trade, a practical profession. Without creating a practical psychological service and without broadening applied research, it would be very difficult to transform psychology into a practical profession similar to engineering.

A very unique situation has evolved in psychologist training, one having practically no analogs in the training of other specialists. Every specialty is doubly represented in the institution of higher education: Universities basically prepare specialists for scientific research and for institutions of higher education, while sector training institutes prepare practical specialists. Psychologists, meanwhile, are trained only in universities and, in accordance with the traditions of university education, basically for scientific work.

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At first glance it would appear quite natural to alter the content of university training with a consideration for the shortcomings revealed in preparation of the students for practical work. However, this could be achieved only at the price of reducing comprehensive scientific training, since in 5 years of college it is impossible to prepare a student identically well for scientific, pedagogical, and practical work. Any attempt at doing so may easily lead to overemphasis of empiricism and to the fact that in a few years we will once again have to solve the problem of improving the training of personnel for scientific research.

The ideal solution to the problem would be to create sector training institutes preparing practical psychologists. The first steps are already being taken in this direction (by the psychological-pedagogical school of the Pedagogical Institute imeni V. I. Lenin; there are also plans for creating a school of psychology in the Academy of the Ministry of Internal Affairs); however, this solution is for the moment as ideal as it is hard to implement. It therefore seems more suitable to broaden the profile of specialists trained in the appropriate schools and departments of psychology in the universities, and to create sector training institutes unhurriedly in parallel. One solution with possibilities would be to create two training plans in the schools and departments of psychology, one for training scientific researchers and a second for training practical workers. Thus we confront yet another unique feature of modern psychology--its intensified differentiation into different areas. This means that in addition to differentiation into theoreticians and practical workers, psychologist training must be differentiated also in relation to specialists in different areas of psychological science--social psychologists, medical psychologists, labor psychologists, and so on, inasmuch as it is impossible to prepare a student simultaneously for all existing areas of psychology. Thus it appears to me that we must specialize the universities to a certain extent in the training of psychologists for particular areas of psychology.

Moscow University, which offers courses in five specialties, must prepare a training plan which would account for all of the factors noted above. In this connection the new training plan of MGU's school of psychology foresees a certain reduction in theoretical courses and expansion of basic courses in particular specialties and in practical work. More than 50 percent of the training time in the existing training plan is devoted to general subjects, about 35 percent of the hours are devoted to training in general psychology, and the remaining time is devoted to specialized subjects. In the new training plan, general education will occupy only 45 percent of the time, and the rest of the time will be split about equally into general psychological and specialized training.

Development of the new training plan is an important matter in specialist training, but it is not the most important. What is most important is preparation of new programs for applied disciplines and for practical and laboratory lessons and creation of the appropriate bases for training, for practical work in production, and for course and diploma projects. Without creating a network of practical psychological institutions that would contain

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such bases, preparation for practical work would inevitably be lacking. Students must receive their practical training at places where psychologists do their practical work, and it is precisely out of the psychologist's practical work that we must extract the training tasks to be presented to students as typical examples.

Many problems are arising in connection with the methods of instruction of psychology itself, and with organizing practical exercises, academic training, and production practice. This is an area of special and great concern.

Another method of personnel training would be to make psychologists out of persons having a higher education in areas other than psychology. One of the unique features of psychology is that a psychologist working in various practical areas must also possess knowledge about the sector in which he must work: The labor psychologist must have a knowledge of modern production; a psychologist involved in development of new training methods must know the study subject with which he is working; a specialist in management psychology must know the fundamentals of management, since otherwise the psychologist's recommendations would be either at the level of common sense or abstract, inapplicable to concrete conditions.

We can avoid these difficulties by broadening the training of psychologists in sector-specific disciplines (engineering, medicine, economics, cybernetics, pedagogics, and so on) or by teaching psychology to specialists of a given practical sector. The second way promises to be less expensive and more profitable, since practical psychologists could be trained in 2.5-3 years of day school (3.5-4 years of night school).

We must also think about raising the qualifications of psychologists already involved in practical work and, equally so, about retraining psychologists for other specialties. Centers for retraining and advanced training of practical psychologists could be created at the leading universities; university instructors, colleagues of scientific research institutes of psychology, and the best practical psychologists could participate in the training afforded by these centers. In parallel with raising their qualifications, students taking courses in these centers could at the same time offer courses of instruction to other students, thus participating in preparation of personnel for practical service and raising the potential of VUZ's.

Psychology now stands at the intersection of many roads which do not represent alternatives for it. Thus the task is to move forward on those roads which promote solution of our society's pressing problems and which at the same time help psychology itself to develop. Completion of this complex task will require unification of the efforts of all psychological institutions and all psychologists of the country.

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It would be best to create a county-wide psychological service in the form of a network of republic psychological training and utilization systems (SNIP) which should become an inherent part of the overall republic system of training and utilizing skilled personnel. Creating the SNIP, we must account for the diversity and uniqueness of local conditions. The Estonian SSR is presently completing its planning of such a system. Its development was based on the experience of training psychologists at Tartu State University. Its experience demonstrated that the rudiments of successful professional activity by graduates of the university lie not only in the sort of work they end up doing but also in the way their training is organized. The main shortcoming of training organization today is the failure to account for specific conditions and possibilities afforded to the work of psychologists. Their training is oriented mainly at research and educational work, and not at practical work.

By planning the SNIP, the Estonian SSR has determined the most promising ways for training, placing, and utilizing qualified psychologists. The technical assignment for development of the SNIP was coordinated with the Estonian SSR Gosplan, and it fully satisfies the republic's requirements. The latter were determined from the needs stated by the production sphere. Utilization of psychologists in productive organizations essentially means arisal of a unique profession--that of the industrial psychologist. There are many problems and difficulties along the road of development of this profession and of organization of its subsequent pursuits. The rather uncertain, groundless, or even incorrect understanding of the tasks and work methods of the specialists must be rectified considerably. One important problem in particular is that of preparing administrators to accept industrial psychology as an effective management tool. The specialists themselves must also gain a deeper understanding of their own role.

The SNIP plan being developed in the Estonian SSR foresees a number of innovations in psychologist training at Tartu State University. The main ones include creation of a specialized department of labor psychology to serve as the basis for training industrial psychologists, alteration of the training plan, and creation of a center dealing with the scientific methodology of industrial psychology. Implementation of these innovations is within the competency of the Estonian SSR Ministry of Institutions of Higher Education and Tartu State University. The Estonian SSR Gosplan, the Estonian SSR State Committee for Labor, and the republic's sector ministries must participate in development of the SNIP. The job of the sector ministries is to define the concrete slots for specialists in psychology, to confirm their tasks and their official responsibilities, concurrently insuring coordination of the activities of individual agencies associated with psychologist training and utilization, and to determine personnel policy relative to the specialists.

The most acceptable variant for training and utilizing industrial psychologists on a national scale is to create the appropriate specialty in schools of

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psychology. Major preparations have been made in this direction by the specialist training laboratory of the Scientific Research Institute of Integrated Social Research at Leningrad University. The model of an industrial psychologist's activity developed by this laboratory has been substantiated by empirical findings, and it can serve as the basis for writing training programs for specialists in psychology, required by Soviet industry. The present training provided and the orientation given to psychologists in the traditional directions (social psychology, labor psychology, and engineering psychology) fail to sufficiently satisfy the demands of industry. We need a new specialization that would be compatible with these demands.

In view of the fact that development of the SNIP is a unique experiment in psychological education, the country's major psychological centers must provide support and assistance to this initiative. We also need to create the appropriate organizational conditions in support of the professional activities of psychologists in the Estonian SSR, and we need to utilize these specialists more actively in solution of pressing problems in production and management.

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PSYCHOLOGY

PRINCIPLES OF PSYCHOPHYSIOLOGY

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[Text]

The Subject of Psychophysiology

The term "psychophysiology" is being encountered with increasingly greater frequency in the scientific literature. Psychophysiology is usually defined as the science of physiological reactions occurring in changing psychological conditions. Hence follows the special interest psychophysicists display toward the dynamics of those physiological reactions (electrocutaneous, vascular, reactions elicited by brain potentials) which change significantly in response to changes in human mental states (14).

However, the outlines of a new stage in the development of psychophysiology as a science on the neuron mechanisms of mental processes are presently taking shape. In this new approach, registration of various physiological reactions continues to be highly significant, but it is not the only thing that is important. This approach to psychophysiology was born in the 1960's in connection with advances in microelectrode registration of individual neurons (4).

The subject of psychophysiology viewed as an independent science at the interface of psychology, neurophysiology, and cybernetics is the neuron mechanisms of mental processes.

The Method of Psychophysiology

The method of psychophysiology can be represented as a man-neuron-model scheme. Research begins at the psychophysical level, at which the laws governing relationships between stimuli and human reactions are established. But the research does not end here, instead proceeding further to clarification of the contribution made by different types of neurons in the laws, established at the psychophysical level, governing the relationships between

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stimuli and reactions. Research is now being conducted in the clinic on the reactions of individual neurons in connection with the need for exerting a therapeutic influence upon the human brain (4). Because such research is limited to a therapeutic framework, neuron research must be conducted in parallel on animals (3,6,6a,13). Psychophysical data and data acquired at the neuron level are brought together in a model of the mental process being studied. This model is built out of neuron-like elements representing the most significant, from the standpoint of information transformation, properties of a real neuron. The most rigid requirements are imposed on the model: The whole model must reproduce the characteristics of the function under analysis at the psychophysical level, and each element of the model must reproduce the characteristic corresponding to the real neuron participating in the given mental function (12). This model is not a final solution to the problem: It is itself a research tool. In fact, being a concrete representation of relationships between neurons, the model can be used as the means for conducting research either at the psychophysical plane, in which case we consider the entire model as a whole, or at the neurophysiological plane, where we determine the characteristics of its individual neuron-like elements. In this case research with the model can be performed in a broader range of conditions than was the case in the initial experiments. Thus experiments with the model can subsequently anticipate research to be carried out at the psychophysical and neuron levels. These preliminary data, obtained from the model, could subsequently be checked out at the psychophysical and neuron levels. Psychophysical and neuron research, in turn, helps to elaborate upon or transform the model. Thus we arrive at a spiral dialectical process of development of our knowledge, where each turn means deeper knowledge on the neuron mechanisms of mental processes.

Data accumulated as of today could be formulated as the fundamental premises or principles of psychophysiology. These principles give the impression of axioms. In fact, however, they are the result of generalizing concrete experimental data.

The Principle of Channel Number-Coding

This principle pertains to both signal coding and reaction coding. A signal is coded by a channel number with the participation of detector neurons. When a certain external stimulus acts upon one of the detectors of a bank of detectors, maximum excitation occurs. The selectively excited detector represents the signal code. When the stimulus changes, the excitation maximum shifts to another detector, thus reflecting change in the signal. Such selective tuning of the detectors is attained by evolutionarily selected systems of pathways between detectors and receptors for neurons at a level lower than detectors. Detectors are a convergent type of pathways: A specific stimulus creates a single excitation maximum in the detector. A reaction or a fragment of a reaction is coded with the participation of command neurons. A command neuron is an interneuron with which the work of the actuating mechanism begins. Transmitted to a set of motor neurons, an

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impulse carried by the command neuron produces a particular pattern of motor units excited to different degrees, thus defining the specificity of the behavioral reaction. The command neuron has a divergent type of pathways: Proceeding through a system of pathways, its solitary impulse generates a behavioral reaction (8).

The Principle of the Conceptual Reflex Arc

The set of neurons responsible for transmission of a signal from receptors to motor units and imparting a certain configuration to the reaction form a reflex arc. The conceptual reflex arc is a model of such a reflex arc, constructed out of neuron-like elements. In correspondence with a real reflex arc, the conceptual reflex arc consists of an analyzer connected to an actuating mechanism. Together with receptors at the input and selective detectors at the output, the neuron analyzer is responsible for reflection of the signal on a screen formed out of a set of detectors. The actuating mechanism, which is triggered by a solitary impulse of a command neuron, causes a given concrete reaction to occur through a complex pattern of pathways.

The Principle of Reflection of Signals on a Sphere

Acting simultaneously upon several independent receptors, a stimulus generates characteristic impulses in each of them. This set of independent receptor impulses forms the impulse vector. Through a system of synaptic pathways, these impulses pass to a detector, which sums the incoming signals. In this case the excitation reaches its maximum in one of the detectors. In order for such a solitary excitation maximum to occur within a set of detectors, the pathways between the receptors and each of the detectors must be selected in a particular fashion, namely such that the impulses traveling along the individual channels are proportional to the coefficients of the pathways. In other words in order that the given detector would respond with maximum excitation relative to all other detectors in the set, the impulses traveling to it must form an impulse vector collinear with the vector of the pathways between this detector and the receptors. In fact, while independent impulses from different receptors make up the components of the impulse vector, independent coefficients of the synaptic pathways between receptors and detectors form the components of the pathway vector. The detector reaction itself, meanwhile, is equal to the sum of the paired products of the incoming impulse and the pathway coefficient. In terms of vector algebra, the detector reaction is a scalar product of two vectors--the impulse vector and the pathway vector. Given constant coordinates for the pathway vector inherent to a given detector, the scalar product attains its maximum when the vectors are collinear--that is, when their components are proportional. A similar line of reasoning would be valid in relation to other detectors. This means that the precondition for attaining maximum excitation is that the characteristics of the detectors must satisfy the equation of a sphere. In terms of a sphere with unit radius, the components

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of the impulse vector must assume the values of directricial cosines--that is, the cosines of the angles formed between the impulse vector and the coordinate axes. Thus the characteristics of the impulses produced by receptors connected to the detectors must be cosinusoids. If the characteristic of the receptors is different, then interneurons with pathway coefficients insuring correction to a cosinusoid at the output must be included between the receptors and the detectors. Such intermediate neurons may be called primary detectors or predetectors. Generating a cosine function at the output. predetectors insure, through proportional pathway coefficients, that a maximum reaction would occur in a selective detector, equal to the sum of the squares of the incoming impulses and satisfying the sphere equation.

Thus an external signal acting on receptors generates, directly or with the participation of predetectors, an impulse vector with components satisfying the equation of a sphere. When the external signal changes the impulse vector changes, and now the excitation maximum occurs on another detector, the pathway vector of which is collinear with a new impulse vector--that is, when the external signal changes, the excitation maximum shifts from one detector to another. The set of collective detectors forming the sphere over which the excitation maximum, the sole one in relation to each signal, moves, can be called, due to its resemblance to the receptor surface, the quasireceptive surface. External signals are reflected by movement of the locus of the impulse over this quasireceptive surface.

The Principle of Measuring Subjective Distances in Angular Units

Coding a signal with a channel number means that a signal in the nervous system is represented by a locus of excitation on a sphere forming the perceptive space. The extent of the subjective difference between stimuli depends on how far apart the detectors representing these signals are located on this surface. The distance between detectors on the sphere forming the quasireceptive surface is measured as the angle between the impulse vectors generated by these signals. An arc delimiting those detectors which represent the signals being compared responds to this angle on the sphere. Thus the subjective distance between stimuli is measured as the angle between the impulse vectors generated by the signals under comparison. In terms of the spherical perception model, the differential threshold, defined as a barely noticeable subjective difference between thresholds, is measured as the angle between two adjacent detectors. When the external signal changes by a threshold amount, the impulse vector shifts from one detector to another neighboring detector. As long as the signal changes by an amount less than that necessary to shift the impulse vector to another detector, these changes in the signal are not perceived subjectively. The subjective distance between stimuli, measured as the angle between impulse vectors representing the signals, is equal to the sum of the differential thresholds, measured as the angles between detectors on the sphere. Given a fixed density of detectors in the neuron analyzer, in angular units the differential threshold is constant. In this case the subjective distance is equal to the sum of the differential thresholds, on the condition that both values are given in angular units.

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The Principle of Vector Addition Accompanying Signal Summation

Because a signal produces an independent impulse in each receptor, the cumulative effect of several stimuli can be determined only by summing the impulses in each receptor taken individually. In the language of vector algebra, this means that if a stimulus generates an impulse vector, then the effect of the sum of the signals is represented by the sum of the impulse vectors generated by each stimulus separately. Thus signals in the nervous system undergo vector addition, in the sense that impulses in each channel are added together independently of one another. This permits us to explain the qualitative changes occurring in perception when two different signals undergo summation.

The Principle of the Invariant Detector and the Invariant Screen

Forming a quasireceptive surface, the detectors examined above encode a signal on this surface by means of the locus of maximum excitation. In this case each selective detector has its own constant set of pathways connecting it with receptors or predetectors. Let us examine a detector having a pathway vector which changes in response to signals transmitted from a supplementary set of detectors. This means that given presence of the same signal in the principal set of detectors, the excitation maximum would move through this set as the pathway coefficients of the principal set change in response to the influence of signals coming in from the supplementary set of detectors. This shifting of the maximum in the principal set would thus be a mirror image of changes occurring in the impulse in the supplementary set of detectors. In the event that the impulse in the supplementary set of detectors changes together with changes in the impulse transmitted to the principal set of detectors, the excitation maximum would remain in the same detector of the principal set. This would happen because change in the impulse at the input of the principal set of detectors would cause the coefficients of the pathways between the detectors and the receptors to change in accordance with the behavior of the impulse in the auxiliary set of detectors. Such detectors in the principal set would be invariant detectors. The set of invariant detectors forms the invariant screen displaying the external signal. Invariant detectors are what are responsible for constancy of perception.

The Principle of Emphasizing Differences Between Signals

The most important function of the nervous system is to isolate signals from an interference background. The mechanism of lateral inhibition is used for this purpose. Lateral inhibition is achieved at the level of selective detectors by a system of inhibitory relationships between them. The magnitude of the inhibitory effect is proportional to the distance between detectors on a sphere, points on which represent individual detectors. As a result of lateral inhibition between selective detectors, their selectivity in relation to an external signal rises. However, the position of

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the excitation maximum on the sphere does not change in this case. Therefore the signal is perceived to be the same as if lateral inhibition had not occurred.

A system of receptors, predetectors, and selective detectors forms a neuron analyzer, which locally services a particular zone of external space. Other zones of external space are serviced by other spatially localized neuron analyzers having the same neuron composition. In this case predetectors of the same types in different spatially localized analyzers are related together by lateral inhibition. As a result of this we have simultaneous contrast-emphasis of differences between stimuli affecting spatially different neuron analyzers.

In addition to lateral inhibition, there is one more mechanism at the level of detectors and predetectors insuring higher differential sensitivity of one local neuron analyzer. This mechanism is one of adaptation in the predetector link. Undergoing adaptation, a predetector's sensitivity decreases to different amounts, namely in proportion to the degree to which the given predetector is stimulated. The sensitivity of a highly stimulated predetector decreases more, while that of a weakly stimulated one decreases less. In this case the relationship among components of the impulse vector changes, and the excitation maximum shifts to another selective detector, which is subjectively perceived as change in the signal in the course of adaptation. Illusory perception results. This illusion is the price we must pay for possessing the biologically expedient function of adaptation at the predetector level, the payoff being higher resolution of the analyzer as a result of adaptation. This increase in differential sensitivity of the neuron analyzer occurs mainly in relation to signals close to the one to which the analyzer undergoes adaptation. Thus changes in any long-acting signal are emphasized (12).

The Principle of Plastic Convergence of Detectors on a Command Neuron

A system of detectors making up a neuron analyzer causes selective reflection of a signal on the quasireceptive surface due to attainment of an excitation maximum in one of the detectors. With this, the function of the neuron comes to an end. The function is now taken over by the actuating mechanism. In order that a signal would produce a specific behavioral reaction, the detectors must be connected to a command neuron responsible for actuation of this reaction. If the detectors are connected to a command neuron rigidly, then this structure produces lock-and-key reactions, as described in ethology. But we are much more interested in variable relationships between detectors and command neurons. A multiplicity of detectors converges upon a single command neuron. But this convergence is plastic: The degree to which a detector is associated with a command neuron changes in the course of learning. As a result of learning, a given behavioral reaction may be elicited by stimuli different from those effective prior to learning. The effectiveness of a stimulus in relation to such a behavioral reaction would depend on which detectors are connected to the

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command neurons and which are disconnected from it. In this case the detectors that had been effective earlier may become disconnected, while previously ineffective detectors may be connected. This would be expressed at the behavioral level as change in the reflexogenic zone of the brain that is effective in producing a behavioral reaction. Plastic convergence means that detectors are variably connected to and disconnected from a command neuron (8).

The Principle of Stimulus-Dependent and Effect-Dependent Learning

Assuming plastic convergence to hold, we can interpret the learning mechanism as a process of alteration of initial relationships between stimuli and reactions. We can distinguish between stimulus-dependent and effect-dependent learning. With stimulus-dependent learning the coefficients of the pathways between detectors and command neurons change only depending on what particular pathways were acted upon. Reinforcement does not play a significant role in this case. With stimulus-dependent learning the coefficients of the pathways between detectors and command neurons may grow (facilitation) or decline (habituation). At the behavioral level, facilitation causes arising of a selective increase in reaction intensity in response to a repeated stimulus. When habituation develops, we observe selective weakening of the reaction in response to a repeated stimulus (9).

Effect-dependent learning is a result of changes in the coefficients of pathways between detectors and command neurons in response to combination of a stimulus with biologically important reinforcement. In this case we are dealing with the classical conditioned reflex (2,7). Here we find that depending on the adaptive significance of the reaction, signals travel to that command neuron which triggers this given reaction. In this case the pathways between detectors participating in this biologically important reaction grow stronger. Pathways between the command neuron and those detectors which represent signals that do not produce an adaptive effect decrease in importance. Thus only those detectors, excitation of which is followed by an adaptive effect from the given reaction, form highly effective associations with the command neuron responsible for the biologically important reaction. Those detectors which trigger a reaction which does not produce an adaptive effect are disconnected from the command neuron responsible for the given reaction. Thus the process of effect-dependent learning proceeds at the level of individual command neurons. Anokhin (1) was the first to suggest the idea that a conditioned reflex could be closed at the level of an individual neuron. The high effectiveness and stability of conditioned reflexes in relation to perturbing influences can be explained by the fact that pooling together, command neurons achieve a state of mutual redundancy in support of a reaction, and the learning process affects these pools as wholes.

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The Principle of Redistribution of Reaction Priorities

In addition to detectors and command neurons, we should distinguish a group of neurons which do not elicit reactions but increase or decrease excitability of command neurons. Such modulating neurons, or modulator neurons, can be subdivided into local modulators and generalized modulators. Locally modulating neurons increase the excitability of one or several command neurons responsible for a particular system of reactions. Generally modulating neurons, which regulate the level of activation, simultaneously act upon all command neurons, emphasizing excitation of those command neurons which had previously existed at a high stimulation level. Thus the reaction to a stimulus depends not only on the effectiveness of pathways between detectors and command neurons but also on the contribution made by modulating neurons which, changing the level of excitation of command neurons, redistribute the reaction priorities.

The Principle of Reaction Uniqueness

A typical feature of behavior is that in any moment in time, only one behavioral reaction occurs. This does not mean, however, that just one physiological reaction occurs. A behavioral reaction is a complex functional system involving an entire set of mutually associated physiological reactions. A behavioral reaction is put into play by a pool of mutually associated neurons. Referring subsequently to individual command neurons, I will be implying representatives of pools of command neurons responsible for behavioral reactions. Inasmuch as occurrence of a reaction depends on stimulation of the command neuron representing it, in order that the behavioral reaction would remain unique just a single command neuron within the composition of command neurons representing different behavioral reactions must undergo excitation. This uniqueness of a behavioral reaction is achieved at the level of command neurons by two mechanisms--growth in thresholds, and intense lateral inhibition between command neurons representing different reactions. As a result of the interaction of these two mechanisms we achieve uniqueness of command neuron excitation and uniqueness of the reaction associated with this neuron. Under otherwise equal conditions, the probability of a behavioral reaction occurring in response to a given stimulus is defined by the coefficients of transforming associations between detectors and the given command neuron. From this standpoint the matrix of the probabilities of transitions from stimulus to reaction, arrived at in behavioral and psychophysical experiments, carries a great deal of information, reflecting the coefficients of the pathways between detectors and command neurons responsible for occurrence of the corresponding behavioral reactions.

Practical Applications of Psychophysiology

The examined models of neuron structures lying at the basis of perception and learning allow us to make important generalizations. Such models have great prognostic value. Thus the principle of channel number coding leads to a spherical model of perception. Research on color vision (10) and study of motion perception (5) have confirmed these prognoses.

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Research on the neuron mechanisms responsible for mental processes, which concludes with modeling the function under analysis in the form of a structure consisting of neuron-like elements, opens up new possibilities for developing the basic ways to mechanically compensate for lost sensomotor functions. In this case the prosthesis replacing the organ of vision, hearing, or locomotion is designed on the basis of the principle of agreement of the characteristics of real neurons and those neuron-like elements out of which the prosthesis is made. This would allow us to achieve a compatibility between the prosthesis and brain neuron structures, such that signals produced by the neuron-like elements of the prosthesis would be adequate to the corresponding neuron structures of the brain.

The bionic aspect of modeling mental functions out of neuron-like elements should be emphasized. Such models may help us in our efforts at designing artificial sense organs for robots.

Finally, acceptance of analysis of neuron activity and of models built out of neuron-like elements as the most important elements of psychophysiological research would enrich the psychophysical methods for studying sensory, motor, and conceptual functions.

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SCIENTISTS AND SCIENTIFIC ORGANIZATIONS

SIXTH INTERNATIONAL BIOPHYSICS CONGRESS

Moscow BIOFIZIKA in Russian No 3, 1979 pp 572-575

[Article by G. R. Ivanitskiy and K. Ye. Kruglyakova]

[Text] The Sixth International Biophysics Congress, which was organized by the IUPAB [International Union of Pure and Applied Biophysics] council, the scientific council and Biophysical Society of Japan, convened in Kyoto (Japan) on 3-9 September 1978. More than 1500 scientists from 39 countries participated in the work of the congress.

The main branches of biophysics were represented at the congress in 24 symposiums and 38 sections, including more than 1000 reports using display stands. There were the most symposiums dealing with bioenergetics, biophysics of hemoproteins, photophysical processes and environmental biophysics. In addition, there were symposiums on the structure of chromatin, mechanisms of spatial organization of proteins and nucleic acids, membranes, molecular bases of excitation and other pressing problems of biophysics. The most impressive [representative?] sections were those dealing with structural and functional organization of proteins (229 papers), membranes (209), regulation and energetics of muscular contractions (148), photobiology (106), neuronal function (72), function of nucleic acids (60), environmental biophysics (25 papers) and others.

We cannot single out any sensational reports; however, the level of sophistication of the congress was quite high. The topics of the congress reflected the established trends in development of biophysics: as before, there was prevalence of papers dealing with structural and functional organization of proteins, nucleic acids, membranes and components thereof. There is also a tendency toward increase in number of studies of cellular mechanisms of regulation and kinetics of biological processes.

This is also manifested in the tendencies of development of experimental technology. In his speech at the opening of the congress, B. Chance (United States), president of the IUPAB council, observed that new equipment based on computer technology is being developed for the study of the dynamics of multiparameter processes in the cell. There must be utmost development of experimental methods based on ultrasonic technology, radiospectroscopy, etc.

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In addition to the main program, the 8th International Conference on the Mossbauer Effect, a seminar on cytochromoxidase and the International Summer School of Biophysics were held prior to the congress. After the congress, 13 different symposiums and conferences were organized (for example, a colloquium on self-organization of proteins, symposium on quantum biophysics and electrokinetic aspects of biological membranes, 8th International Conference on Magnetic Resonance in Biological Systems, seminar on biocalorimetry and others).

Although we cannot discuss extensively in this brief report all of the papers, we shall dwell only on some of the ones delivered at the symposiums.

Research dealing with the structure of membranes and molecular mobility in biological membranes was represented at several symposiums. It can be arbitrarily divided into three main problems: physicochemical properties of proteins and phospholipids as the main chemical components of membranes; specialized membranes of animal and bacterial cells; model membranes (liposomes, synthetic bilayer membranes, lipid monolayers and others). Original approaches and modern physical and physicochemical analytic methods were used in all of these investigations.

Much interest was aroused by the paper of S. Fleisher (United States), which dealt with phospholipid-protein interactions in biological membranes on the example of analysis of reconstruction of two enzymatic systems, oxybutyrate dehydrogenase from the internal mitochondrial membrane and fragments of sarcoplasmic reticulum of the rabbit skeletal muscle. T. Thompson and J. M. Show (United States) successfully used the method of proton nuclear resonance to study the decrease in bilayer asymmetry produced with phosphatidyl-exchanging protein, and they determined the half-life (26 days) for migration of lipids from the external monolayer to the internal. Analysis of lateral mobility in model and native biomembranes by the method of spin-labeled phospholipids was the topic of the paper of McConnel (United States). Much attention was attracted by the paper of M. Montal (United States), who was the first to succeed in obtaining asymmetrical flat phospholipid membranes containing a minimal amount of organic solvent. The author was able to insert animal rhodopsin into a flat bilayer membrane and to demonstrate that potential-dependent ion channels are formed under illumination. The channels opened at zero voltage and closed when the voltage was raised. A simple model of phototransduction was proposed, in which rhodopsin functions by means of formation of light-activated and potential-dependent transmembrane channels. R. M. Franklin (Switzerland) reported on the feasibility of complete disassembly of lipid-containing PM2 bacteriophage and subsequent reconstruction thereof in several stages. The reconstructed bacteriophage presented biological activity. Y. Kagawa (Japan) submitted data concerning the possibility of complete reconstruction of H^+ -ATPase from elements of isolated membranes of thermophilic Ps3 bacteria. The ATPase of this object is resistant not only to temperature, but other factors (alcohol, urea and others); there are strong bonds between its subunits, and they are readily restored after dissociation. The paper of P. Malathi and R. K. Crane (United States) prompted an

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animated discussion; it dealt with reconstruction of Na-dependent transport of alanine and glucose in liposomes on the basis of "membrane material" from membranes of the brush border of epithelial cells of the small intestine and kidney.

There were two sessions of a symposium on bioenergetics. The paper of V. P. Skulachev (USSR) dealt with the conception of the role of the Na^+/K^+ gradient in membrane accumulation of energy in a living cell. This conception is confirmed by the experiments of D. Oesterhelt et al. (FRG). The papers presented by T. Efrey (United States), D. Oesterhelt (FRG), R. Henderon (England) and others submitted new data on bacteriorhodopsin. A. Leninger (United States) delivered a paper on stoichiometry of the proton in the course of electron transport and ATP hydrolysis in mitochondria. M. Wikstrom (Finland) reported on the mechanism of the cytochromoxidase reaction. He expounded the view that cytochromoxidase functions like a proton pump to implement transfer through the membrane of four H^+ ions for every atom of oxygen consumed.

At the meetings dealing with molecular bases of cell excitability, there was the most comprehensive coverage of questions pertaining to the role of calcium channels in the neuronal membrane (P. G. Kostyuk, USSR), mechanisms of sodium and potassium gating currents (R. Keynes, England), as well as current responses of the skeletal muscle membrane to a drastic change in potential (W. Chandler, United States).

At the symposium on mechanisms of spatial organization of proteins and nucleic acids, papers were delivered on theoretical modeling of the process of self-organization of protein structures (O. Ptitsin, USSR; G. Scheraga, United States), kinetics of protein rolling [bending] (R. Baldwin, United States), as well as on the experimental search for intermediated (partially rolled) forms of protein molecules (T. Creighton, England; K. Kuwajima, Japan) and others.

Analysis of the papers delivered at the congress that dealt with chromatin revealed that, at the present time, much attention is being given to the complex approach to the study of chromatin structure by means of use of modern biochemical and biophysical methods, which permits demonstration of the correlation between structural distinctions of chromatin and its functional activity. The paper of E. M. Bradbury (England) was concerned with the structure of chromatin; it offered evidence of the existence of two types of nucleosomal particles that differ in sedimentation coefficient (5S and 11S) and a higher ratio of nonhistone proteins to histones in the 11S monomer. The paper of G. Felsenfeld (United States) dealing with the structure of nucleosomes and organization of chromatin proteins and several other papers (K. Watanabe, Japan; G. S. Stein et al., United States) described studies of the properties of reconstituted DNA-histone complexes. It was shown that appearance of a complex of DNA with intranucleosomal histones is multiphasic, and it resembles appearance of polynucleosomal chains of chromatin. The complex of DNA with total histones resembles unadulterated chromatin in its melting features.

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The papers dealing with the structure of nucleic acids can be divided into several groups, depending on the objectives of the studies. One of them could include studies of complex formation and interaction of different components of DNA and RNA in aqueous solutions (S. Morimoto, Japan; A. Zielenkiewicz, Polish People's Republic; B. Perly et al., France, and others). Theoretical and experimental data on the secondary structure of DNA were submitted in the papers of T. Sato (Japan), Z. Dzierzewicz (Polish People's Republic) and J. M. Schurr (United States). A cycle of studies was reported on the structure of DNA complexes (DNA + drugs, proteins, dyes) with the use of new methods (spin labeling, electron dichroism and others) (Y. Nishimura, Japan; B. B. Singhet et al.; India). We must comment on the achievements of Japanese scientists, who proposed several sensitive methods and demonstrated new instruments for recording the structural organization of nucleic acid molecules and components thereof.

Virtually all aspects of investigation of the process of muscular contraction were represented at the congress: properties of muscle proteins, organization thereof in the sarcomere, molecular mechanisms of generation of tension, regulatory systems of muscles, energetics of muscular contraction, etc. Prominent specialists in muscular contraction delivered papers at the two sessions of the symposium dealing with these questions: H. E. Huxley (Great Britain), A. Weber (United States), Y. Tonomura (Japan), A. G. Szent-Gyorgyi (United States) and others.

Many papers were delivered on the subject of photophysical processes. In these papers, attention was focused mainly on problems of photosynthesis and photoreception. The paper of G. Feher (United States) dealt with the chemical composition, structure and properties of reactive centers isolated from photosynthesizing bacteria. It was shown that the centers consist of three sub-units of protein with attached prosthetic groups: 4 molecules of bacteriochlorophyll, 2 molecules of bacteriopheophytin, 2 of ubiquinone and 1 bound atom of iron. The sequence of transport of an electron in the reactive center, from bacteriochlorophyll to bacteriopheophytin was studied with the use of picosecond laser beams (W. W. Parson, United States).

L. N. M. Duysens (Holland) reported on electron transport in the photosystem of plants and, on the basis of his results, he proposed a hypothetical model of the structure of reaction centers of the photosystem. The model contains a chlorophyll dimer as the electron donor and plastoquinone as the electron acceptor.

Most of the papers, submitted in the form of reports using display stands, dealing with photosynthesis were primarily concerned with the study of primary photobiological processes in chloroplasts, primarily processes of bacterial photosynthesis, as well as modeling of photosynthetic processes.

As compared to the preceding congress (in Denmark, 1975), more papers were delivered at the one in Japan that dealt with primary stages of photosynthesis and other photobiological processes. Questions pertaining to photoreception

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were discussed in three aspects at this congress: structure of visual pigments, photochemistry thereof and secondary photoreceptor processes. Most of the findings were made with model systems (H. Kakitani, Japan; A. Kropf, United States; and T. Yoshizawa, Japan).

Environmental biophysics was the topic of three symposiums, at which there was discussion of questions related to the mechanisms of action of chemical and physical environmental factors on the body and biological systems (V. Lyatsov, USSR; T. Sigimura, Japan; Y. Fujiwara, Japan; and H. Glubrecht, FRG); questions of correlation between living organisms and the environment (adaptation of organisms to life in a given environment) were discussed by M. Lindauer (FRG), Y. Tamaki (Japan), A. Michelson (Denmark), H. W. Lissman (England) and H. Suga (United States); there were also papers dealing with biophysical problems related to life in biocenoses with high salt levels (A. Finck, FRG; A. Muhammed, Pakistan; R. H. Nieman et al., United States).

There was a special symposium on methodological questions of obtaining immobilized enzymes from the cells of microorganisms and using these systems in industry and clinical practice (J. Chibata, Japan; J. F. Kennedy et al., England; J. Klein, FRG, and others).

In the studies reported to the congress, extensive use was made of such modern physical analytical methods as x-ray analysis, electron spin resonance and nuclear magnetic resonance spectroscopy, electron microscopy and others.

X-ray analysis of proteins and complexes thereof was the topic of the papers of K. Sasaki et al. (Japan), T. Tsukahara et al. (Japan) and X-ray analysis of cholera toxin was the topic of A. Uonas (United States); X-ray analysis of tyrosine RNA synthesis was discussed by D. M. Blow (England); the same method was used to study processes of muscular contraction by K. Holmes (FRG) and others.

Nuclear magnetic resonance spectroscopy was discussed in papers dealing with studies of the structure of proteins, nucleic acids, membranes, muscles, brain and others (Ch. Ho, United States; W. Ribbing, FRG.; D. Torchia et al., United States; T. Higashijima, Japan, and others).

K. Wuthrich (Switzerland) discussed new possibilities for the study of the conformation of biopolymers by the method of high resolution nuclear magnetic resonance; W. L. Peticolas (United States) delivered a paper on the use of laser Raman spectroscopy for quantitative evaluation of the secondary structure of proteins and nucleic acids in solution.

Quantum chemistry methods were used for the study of processes of electron transport, energetics of enzymatic catalysis and transfer of excitation energy (D. Devault, United States; A. Pullman, France; S. Yomosa, Japan; and W. Lipscomb, United States).

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There was a separate symposium dealing with a new method of analysis of the structure of biological objects based on three-dimensional reconstruction. Analysis of three-dimensional structures on the basis of their electron microscopic images is the classical direction in this field (L. D. Peachey, United States). H. Takasaki (Japan) discussed the possibility of measuring the topography (curvature of surfaces) of different microobjects ranging in size from a few millimeters to several meters, on the basis of the moire effect. On behalf of a team of scientists, P. Lauberbur (United States) reported on the new principles of reading information obtained by means of nuclear magnetic resonance.

The papers delivered at this congress on modeling of biological systems reflected various levels of research, both with respect to the objects studied and methods used. A spatial model of interacting populations in a heterogeneous environment was discussed in a paper by Japanese scientists (K. Kawasaku et al.). Some theoretical stationary properties of two classes of multienzyme model systems were analyzed in the paper of T. L. Hill (United States). The feasibility of modeling the immunological response to cancer was the topic of G. Nikolis and Lefevre (Belgium). N. Yamamura (Japan) discussed a mathematical model of two interacting species and the influence of fluctuations in environmental properties.

We must mention the fact that the congress was well-organized, its services functioned efficiently, and there was an excellent complex of buildings in Kyoto that were specially intended for international congresses. A new IUPAB board was elected during the congress. Prof Ebashi (Japan) became the president and K. Wuthrich (Switzerland), the general secretary.

On the whole, the congress demonstrated that biophysics is a rapidly developing science that has much practical importance. The next congress will convene in Mexico in 1981.

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TOXICOLOGY

UDC 612.815.2;598.126;595.799

EFFECT OF PRESYNAPTIC NEUROTOXINS FROM BEE AND COBRA VENOM ON SPONTANEOUS SECRETION OF TRANSMITTER SUBSTANCE BY MOUSE MOTOR NERVE ENDINGS

Moscow BYULLETEN' EKSPERIMENTAL'NOY BIOLOGII I MEDITSINY in Russian No 5, 1979 pp 396-399

[Article by M. A. Kamenskaya, L. G. Magazanik, Ye. R. Kotova, N. K. Satybaldina, A. I. Miroshnikov, and Yu. R. Apsalon, Department of Human and Animal Physiology of Moscow University imeni M. V. Lomonosov, the Synaptic Process Biophysics Group of the USSR Academy of Sciences Institute of Evolutionary Physiology and Biochemistry imeni I. M. Sechenov, Leningrad, and the Laboratory of Protein Chemistry of the USSR Academy of Sciences Institute of Bioorganic Chemistry imeni M. M. Shemyakin, Moscow]

[Text] Neurotoxins with presynaptic action have been isolated from animal venoms. Many of these toxins are also type A₂ phospholipases (PLA), enzymatic activity of the toxins being significant to manifestation of their toxic effect (3-6,9,11).

To clarify the mechanism behind the blocking presynaptic action of neurotoxins of this type, we felt it important to study the influence of PLA isolated from bee venom (PB) and the Central Asian cobra *Naja oxiana* (PC) on spontaneous transmitter release by motor nerve endings of a mammal (a mouse). PB and PC are polypeptides with molecular weights of 16,000 and 12,000 and phospholipase activities of 11 and 1.5 μmoles substrate per 1 μ protein per minute; when injected subcutaneously into white mice, their LD₅₀ is 5 and 80 mg/kg respectively (1).

Research Methods

Miniature end plate potentials (MEPP) were recorded intracellularly in an isolated neuromuscular preparation of diaphragm tissue from male white mice. The preparation was incubated in a 2 ml bath containing physiological solution saturated with (karbogen) at 18° or 30°C, pH 7.2-7.4 (3). The MEPP frequency was recorded continuously in the same synapse for 1-3 hours. Moreover we measured the MEPP frequency of several other synapses at the beginning and at the end of the experiment, successively introducing the microelectrode into different muscle fibers.

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Research Results

PB at concentrations of 25 and 50 µg/ml and PC at a concentration of 50 µg/ml did not influence the resting potential of muscle fibers subjected to 1-3 hours of incubation. Nor did we observe changes in the mean amplitude of the MEPP recorded, which permits the hypothesis that the sensitivity of the postsynaptic membranes to the transmitter's action does not change either.

Lengthy, constant observation of the MEPP frequency demonstrated that three successive phases are typical of the effect of both neurotoxins: 1) A phase of an initial decline in the MEPP frequency; 2) a phase of growing frequency; 3) a phase of a dramatic decline in the MEPP frequency down to complete blockade of spontaneous release (see Table and Figure 1). The duration of each phase and the expressiveness of the effect varied in different experiments.

Effect of PB and PC on MEPP Frequency in Mouse Diaphragm Tissue ($M \pm m$)

(1) Токсин	(4) Концент- рация, мкг/мл	(5) Темпера- тура, °C	(6) Число опы- тов	Норма (7)		Фаза начального блока (9)		Фаза учащения (10) МПКП		Фаза вторичного (11) блока	
				(8) имп/с	%	(8) имп/с	%	(8) имп/с	%	(8) имп/с	%
(2) ФП	25	18	8	0,73±0,06	100	0,34±0,06	46,6	22,36±8,60	3630	0,29±0,06	39,7
ФП	25	30	6	1,09±0,18	100	0,31±0,03	28,4	4,00±9,83	3670	0,23±0,07	21,1
ФП	50	30	5	1,08±0,15	100	0,31±0,02	28,7	36,39±9,73	3369	0,25±0,04	23,1
(3) ФК	50	30	12	1,25±0,13	100	0,41±0,05	32,8	30,78±7,29	2462	0,34±0,04	27,2

Key:

- | | |
|-------------------------|---------------------------------|
| 1. Toxin | 6. Number of experiments |
| 2. PB | 7. Normal |
| 3. PC | 8. Pulses/sec |
| 4. Concentration, µg/ml | 9. Phase of initial blockade |
| 5. Temperature, °C | 10. Phase of growing MEPP |
| | 11. Phase of secondary blockade |

For practical purposes the initial decline in MEPP frequency began immediately after introduction of PB or PC into the bath (see Figure 1), and it attained its maximum in 5-30 minutes, after which the frequency, which varied significantly (by a factor of 2-100) in different synapses and in relation to its nature (long, stable rise or individual high-frequency MEPP discharges), increased. At 30°C the toxin's effect was pronounced more clearly in each of the phases than at 18°C (see Table). In the presence of PC the first phase was usually relatively short, though quantitative changes in MEPP frequency in response to the two neurotoxins were identical.

The enzymatic activity of PLA depends on presence of Ca²⁺ in the medium. When the Ca²⁺ level decreases to 1·10⁻⁵ M, PC and PB practically lose their capability for hydrolyzing the substrate. This makes it possible to study the relationship between the presynaptic and enzymatic activity of PB and PC.

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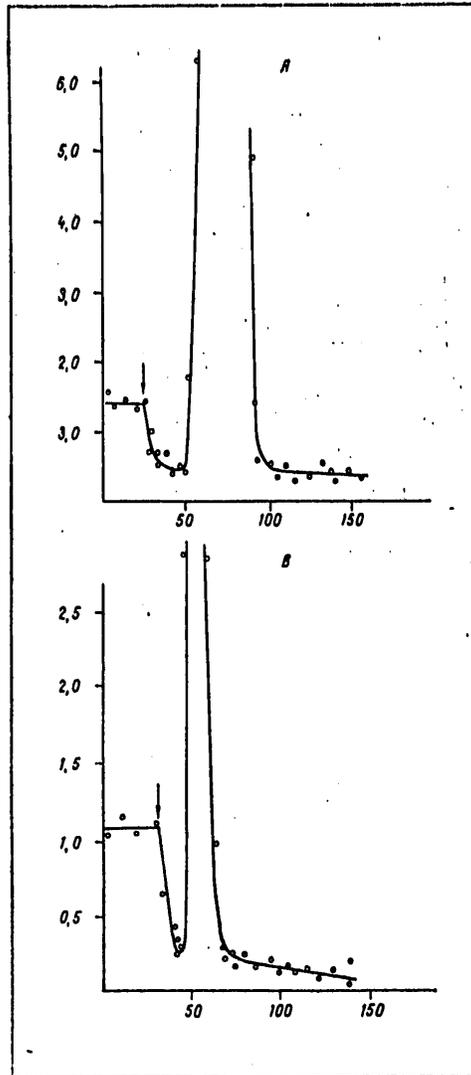


Figure 1, Temporal Course of the Effect of PB (A) and PC (B) at 50 $\mu\text{g}/\text{ml}$ Concentration at 30°C: Abscissa--time (min); ordinate--MEPP frequency (pulses/sec). Arrows indicate moments of addition of the toxins to the solution

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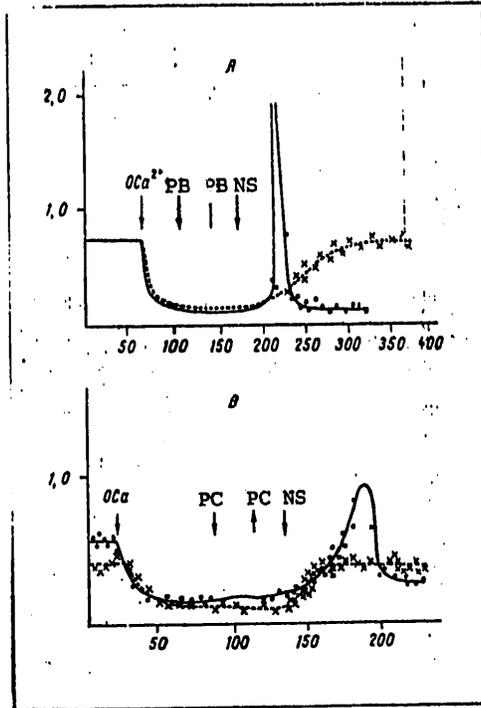


Figure 2. Effect of PB (A) and PC (B) Following Incubation of Preparation in Calcium-Free Solution Containing EGTA: Arrows indicate moments of replacement of normal physiological solution (NS) by calcium-free solution (0 Ca^{2+}), addition of toxins, the start of rinsing of the preparation with calcium-free solution, and replacement of calcium-free solution by normal physiological solution. Solid curve--experiment, broken curve--control (replacement of solutions without addition of PB or PC). Other symbols are the same as in Figure 1

When the preparation was placed in a solution devoid of Ca^{2+} but containing 3mM Mg^{2+} and 1 mM (EGTA) (the concentration of ionized Ca^{2+} in this solution must be below $1 \cdot 10^{-9} \text{ M}$), the MEPP frequency decreased significantly (by a factor of 5-7), inasmuch as spontaneous release of transmitter substance from mammalian nerve endings depends directly on the concentration of extracellular Ca^{2+} (7). When introduced into a calcium-free medium, PB and PC did not cause any sort of changes in MEPP frequency (Figure 2). However, if free neurotoxin was carefully rinsed out of the preparation with the same calcium-free solution and then replaced by normal physiological solution

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(2 mM Ca^{2+}), a rise in the MEPP frequency was observed. In control experiments the MEPP frequency only returned to its initial level, while in preparations subjected to the action of PB or PC (10 experiments) the frequency exceeded the initial level by 3.5 and 1.3 times respectively. After this the MEPP frequency declined, though in the control group it remained constant (see Figure 2). These experiments show that, first, in the absence of Ca^{2+} PB and PC lose their capability for altering the MEPP frequency and, second, the toxins remain firmly bound to their targets. It should be noted, however, that incubation of the toxin in calcium-free solution significantly weakens the subsequent presynaptic effect arising following addition of Ca^{2+} . This may be the consequence of partial reversibility of neurotoxin-target binding.

In order to permit analysis of the mechanism of action of the neurotoxins, we studied the influence of agents intensifying spontaneous transmitter secretion on poisoned neuromuscular preparations. In particular it was important to clarify the nature of the third phase in the action of neurotoxins--blockade of spontaneous release. For this purpose we: 1) increased the K^+ concentration in the solution to 20 mM; 2) increased solution osmotic pressure by 2.5 times by adding sucrose; 3) added $5 \cdot 10^{-6}$ M 4,5,6,7-tetra-2-trifluoromethylbenzimidazole (TTFB)--an agent that separates oxidation from phosphorylation--to the solution. These factors cause a significant increase in the MEPP frequency, since they increase the concentration of ionized Ca^{2+} in nerve ending axoplasm. However, there are different mechanisms behind this increase. An increase in the K^+ concentration causes depolarization of nerve endings and thus an increase in the flow of Ca^{2+} from extracellular fluid into exoplasm (8,10). In the two latter cases ionized Ca^{2+} is released from its extracellular deposition sites, mainly the mitochondria (2,7).

We compared the effects of these factors on the control preparations and on experimental preparations during the phase of action of PB and PC in which the MEPP frequency declined significantly following its initial growth--that is, in the period of blocked spontaneous release. In the presence of 20 mM K^+ , the mean MEPP frequency was found to be identical in control and PB- or PC-poisoned preparations-- 56.6 ± 9.0 (10), 53.8 ± 9.7 (9), and 57.7 ± 14.1 (10), respectively. Similar results were obtained when solution osmotic pressure was increased: The MEPP frequency in the control was 15.5 ± 5.5 (26), while in poisoned preparations it was 18.4 ± 4.6 (34) and 21.0 ± 6.1 (7) respectively. It should be considered that the relative increase in MEPP frequency in poisoned preparations was even somewhat greater, inasmuch as the initial MEPP frequency (prior to exposure to these factors) was reduced by the action of the neurotoxins. Nonuniformity in growth of the K^+ concentration was noted only in the presence of PC: Growth in the MEPP frequency was so great in some synapses that we were unable to measure it precisely, while in other synapses no growth occurred at all. It could be assumed that PC does nevertheless cause some disturbance of the mechanism responsible for coordination of depolarization and secretion in presynaptic endings. TTFB caused an immeasurable avalanche-like increase in MEPP frequency; this effect was qualitatively the same in the control group and following exposure to the

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neurotoxins. These facts indicate that growth in the Ca^{2+} concentration in axoplasm of poisoned nerve endings effectively increases the NEPP frequency-- that is, we do not observe signs of exhaustion of the reserve of accessible transmitter substance.

Thus the effects of PB and PC revealed in our experiments on mice are similar in general to the effects of β -bungarotoxin (5,6,11), notexin (5), and PB and PC (4) demonstrated earlier in experiments on frogs: The same three phases are observed in the changes experienced by the MEPP frequency, and the action of the neurotoxins depends significantly on presence of Ca^{2+} in the medium. This permits us to think that there exists a general molecular mechanism behind toxic affliction of nerve endings by these polypeptides. Their capability for enzymatically affecting phospholipids of the presynaptic membrane apparently plays an important role in this mechanism. However, neurotoxins may bind with nerve endings even in the absence of Ca^{2+} and, correspondingly, in the absence of phospholipase activity, which allows the hypothesis that there is some sort of specific target on the presynaptic membrane which is capable of selectively sorbing neurotoxins.

The causes behind phasal changes in the level of transmitter release have yet to be thoroughly clarified, but the obtained data do allow the assertion that the blocking phase is not associated with exhaustion of the transmitter reserve elicited by the preceding period of higher activity.

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PUBLICATIONS

NEUROPHYSIOLOGICAL STUDIES OF THE SYSTEMIC MECHANISMS OF BEHAVIOR

Moscow NEYROFIZIOLOGICHESKOYE IZUCHENIYE SISTEMNYKH MEKHAUZMOV POVEDENIYA
in Russian 1978, signed to press 31 Aug 78, pp 2, 3-8, 239-240.

[Annotation, introduction and table of contents from book by V. B. Shvyrkov,
"Nauka" Publishers, 240 pages, 3150 copies]

[Text] The research is dedicated to an analysis of the mechanisms of behavior from the standpoint of the theory of the functional system created by P. K. Anokhin, and is based on the necessity of the systemic approach to their study. The elementary behavioral act from the standpoint of P. K. Anokhin's theory is considered as a cycle of "exchange of information" between the environment and the organism. Mechanisms which draw the individual neuron into the system of the behavioral act are examined. The correlations of psychical, systemic, and neurophysiological processes in behavior are examined.

Introduction

The behavior of living organisms is the subject of investigation of many sciences in each of which specific aspects of behavior are studied. This circumstance, as R. Khaynd notes in the preface to his book (1975), does not allow us to define our understanding of "behavior" in one way. However, for many provinces of investigation, including for neurophysiology and psychology, behavior in the most general scheme can be defined as the relationship of the organism and the environment. Therefore the study of behavior must include an analysis both of the environment, the processes inside the organism, and the interaction of the organism with the environment. An understanding of "behavior" must include all types of interrelations of the organism and the environment, including those which find a reflection in the psychology of the organism.

At the present time hardly anyone will deny the role of psychology in behavior. Together with this it is obvious that at the base of behavior

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lie physiological functioning processes of certain morphological structures of the organism. The correlation of psychical and physiological processes comprises the so-called psychophysiological problem.

The materialist thesis about the unity of behavior and psychology excludes the possibility of a full understanding of behavior mechanisms without the solution of the question about the role of psychical processes in behavior. Any theory of behavior throwing out or not including psychical processes, also, does not present to us the corresponding real actuality, in as much as exactly through psychical processes, through informational correlations, the external environment conditions behavior, a concept which found a reflection in the positions regarding the reflecting and the regulating role of psychology in behavior. At the same time the unity of behavior and psychology assumes the impossibility of psychical processes arising, torn away from behavior and from defined physiological processes. Thus, one or another solution of the problem of the mechanisms of behavior by necessity leads to one or another solution of the psychophysiological problem, also.

The solution of the psychophysiological problems can not be attained on a physiological or a psychological basis only and, consequently, neither physiology nor psychology can give a complete description of behavior. The latter can not be attained by way of a direct comparison of psychical and physiological processes either. As A. N. Leont'yev justly notes (1975, p. 7), "The matter is thus that no direct comparison between psychical and cerebral physiological processes yet solves the problem. The theoretical alternatives which arise with such direct convergence are well known: either what results is the hypothesis of parallelism, in a fatal way leading to an understanding of psychology as a epiphenomenon, or it is the position of naive physiologic determinism with the reduction of psychology to physiology flowing from it, or, finally what results is the dualistic hypothesis of psycho,physiological interaction, which allows the action of the nonmaterial psychology on material processes proceeding in the brain. For metaphysical thinking any other solution simply does not exist; terms covering those same alternatives simply change.

At the present time it has become obvious that the synthesis of psychology and physiology in a description of behavior is possible only on some foundation which is higher and more general for both sciences. Such a foundation is the systemic approach, which is developing now in many spheres of knowledge (Anokhin 1973a; Kedrov, 1974; Kuz'min, 1976; Lomov, 1975; et. al.). Among the large numbers of variants of the systemic approach, the theory of the functional system developed by Academician P. K. Anokhin (1935-1974) seems to us the most adequate for the problems of physiology and psychology and for the problem of their synthesis in a description of behavior. In the explanation of behavior this theory proceeds directly from the most general biological theory--the theory of evolution.

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Actually, in contrast to many variants of the systemic approach in biology proposing to study the properties of the systems on formal models (Mesarovich, 1970), the theory of the functional system is wholly based on biological facts and already places the concept of survival, or the useful adaptive result at the base of the means of isolating the system. Like all fundamental initial concepts (Kedrov, 1962), concepts of the system and of the result are defined in the theory of the functional system through their relationship. The result--this is the condition of the environment, promoting the survival of the system. The system--this is the sum total of elements organized to attain this result. The basic result which biological systems achieve in the final analysis is survival. From this vantage point the behavior of biological systems is goal oriented, any behavior being brought about for the attainment of one or another useful adaptive result, promoting, in the final analysis, survival.

Types of interactions of the organism and the environment of course are very diverse; one may define behavior as such an interaction in which both the organism and the environment appear as whole. Then behavior will appear like a two-way exchange of organization or information between the environment and the organism, which can be brought about only by informational or specifically systemic processes, not reduced to separate physiological processes or to separate influences of the environment.

Systemic processes describe the condition both of the organism, and of the environment; therefore, a neurophysiological or psychological description of behavior is a particular description of one and the same systemic processes of the correlation of the complete organism with the environment.

From this point of view the description of the correlation of the organism and the environment in terms of systemic processes should be a special subject of "systemology". The correlations between systemic and elementary neurophysiological processes appear as the relationships between information and its material carrier, in so far as systemic processes are distinctive informational processes (Ferster, 1964; Gorskiy, 1974). The correlations, then, between psychical and systemic processes turn out to be the relationships between internal and external information. External information has the attribute of organizing elements of the environment, and internal information, the organizing of elements of the organism. Thus, the comparison of neurophysiological and psychical processes is possible only through qualitatively distinctive systemic processes, which inside the organism exist as processes of organization of various elements in one whole--the functional system.

In as much as systemic processes, one of the aspects of whose examination is psychology, inside the organism are processes exactly of the organization of physiological functions, then such a point of view evades the identification of psychical and physiological processes. It evades the psychophysiological parallelism as well, because systemic processes, these are processes of the organization of exactly physiological functions, and psychology proves to be

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a product of the brain. Because the internal organization is defined by the organization of the environment, that is, by its object structure, then psychology can not be excluded from an analysis of the mechanisms of behavior. And finally, because systemic processes "consist" exclusively of physiological processes and the new quality is attained exclusively at the expense of their organization, then physiological and psychological determinism of behavior proves to be in indissoluble unity and do not exist without one another, which excludes any psychophysiological interactions.

It is obvious that this point of view conforms with the notions about the correlation between psychology and the brain as between information and its carrier, developed from the philosophical positions. (Ponomarev 1967; Dubrovskiy, 1971, 1976). Thus, the theory of a functional system serves as that base on which the experimental solution both of the problem of mechanisms of behavior, and of the psychophysiological problem can be achieved. From the standpoint of this theory one may examine the neurophysiology of behavior and of psychology as the study by neurophysiological methods of the systemic processes of organizational exchange between the whole organism and the object environment.

In the study of behavior the problem of the elementary phenomenon was always considered key, defining all further theoretical constructions and the direction of searches. From the times of Descartes the answering reaction of the organism to one or another agent of the external environment was always taken as the elementary manifestation of behavior. Between the "stimulus" and the "reaction" following after it there lasts a definite interval, which in various aspects is termed the "delay", "reaction time," "time of reflex," etc.

The polemics on the question about the processes occurring in this interval collected in themselves like in a focus, all the contradictions of psychology, physiology, and other sciences studying the brain and behavior. The problem of determination of behavior, the psychophysiological problem, the problem of the localization of functions, cybernetic problems of the coding of information and the regulation of the relationship of the organism with the environment, and all other general biological problems of behavior and psychology one way or another are linked with the clarification of the mechanisms of the elementary behavioral act.

From time immemorial this interval has been filled with psychical processes such as perception, collation, remembering, etc. The measuring of this interval in one or another of the modifications of experiments was widely used for a description of the most varied psychical processes and conditions, it being also accepted that the "method of measuring the reaction time is the best method for studying higher functions and has a great future." (Shoshol', 1966, p 316)

Regardless of the complexity and the diversity of processes which they link with the elementary behavioral act, the neurophysiological treatment of the processes occurring between the "stimulus" and the "reaction" for a long

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time was reduced to conducting the excitation from the receptors to the effectors, as this was dictated by the reflex theory.

The conception about the behavioral act as a reflex was based not on the direct study of neuronal mechanisms of behavior, not on physiological facts, and not even on anatomical conceptions, but exclusively on the ideas of mechanical determinism. In his "Answer of a physiologist to psychologists," I. P. Pavlov wrote, "It is generally accepted that the idea of the reflex comes from Descartes, and what was then known about the detailed construction of the central nervous system and of its activity? Actually the physiological-anatomical separation of sensory nerves from motor nerves took place only in the beginning of the nineteenth century. It is clear that precisely the idea of determinism comprised for Descartes the essence of understanding of the reflex, and from here issued forth the Cartesian conception about the animal organism likened as to a machine. All the succeeding physiologists understood the reflex thus, attaching individual activities of the organism to individual stimuli, gradually isolating the elements of the nervous constructions in the form of various afferent and efferent nerves and in the form of special paths and centers of the central nervous system and collecting, finally, at the same time the characteristic traits of the dynamics of this last system." (1949, p 495)

Already at the moment of its arising, the idea of a reflex "made the first breach in the strong wall of mystical and religious conceptions separating the investigator from real facts." (Anokhin, 1945, p 6) The principle of determinism, whose foundation was laid in the idea of the reflex, was used not only for the struggle with the explanation of behavior from the teleological position of the idealist persuasion, but also served as a natural methodological base for experimental investigations of the nervous system. Contemporary achievements of neurophysiology became possible only on the basis of the analytical approach, allowing neurophysiologists working with local processes or substrates to use that very approach, which was applied and in a glowing way justified itself in mechanics.

At the present time the principle of "mechanistic determinism" (that very "linear," that very "naive physiological") in application to the explanation of biological processes and behavior is criticized from the most varied positions, including the philosophical (Dubrovskiy, 1971; Serzhantov, 1974), the cybernetic (Menitskiy, 1975; Svinitskiy, 1976), the psychological (Lomov, 1975), the biological (Oparin, 1964), and the neurophysiological (Berns, 1969; Belenkov, 1975, 1976; Dzhon, 1973; Sudakov, 1976; et. al.).

Although the unsatisfactoriness of the reflex explanation of the elementary behavioral act for many was obvious a rather long time ago, however, the elaboration of more constructive solutions to this problem for a long time was checked by that circumstance, that in order to repudiate the many century reflex tradition in physiology an entirely significant reconstruction of the entire system of conceptions which had taken shape was necessary. As B. Berns notes with regard to one of the early and brightest critics of

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the reflex "The argumentation of Leshli was weak...because...Leshli subjected the reflex or telephonic theory of behavior to a quantitative verification and brought to light its groundlessness, but did not offer another perspective system of understanding at all." (1969, p 19)

The theory of a functional system created by P. K. Anokhin gives us such a system of understanding. As V. F. Serzhantov thinks, "the acceptance of this conception will have certain consequences for the entire theoretical system of biology and psychology; the principle of a functional system will allow us to give a deeper interpretation of biological and psychological concepts formulated in science up to this time, from whence issues forth the necessity of the reconstruction of the entire conceptual structure of these provinces of science." (1974, p 74)

The application of the conceptual apparatus of the theory of the functional system to the problems of the elementary behavioral act changes in a fundamental way the very methodology of research. Therefore the analysis of neurophysiological mechanisms of the elementary behavioral act from the standpoint of the theory of the functional system requires a preliminary examination of behavior in the concepts of this theory.

We will carry out such an examination in a comparison with well known and usual reflex conceptions; however, our basic goal will be not a comparison of two approaches, but a definition of the object of investigation and the setting of concrete problems, subject to experimental neurophysiological solution.

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